US Army Corps
of Engineers®
Savannah District

Glades Reservoir
Draft Environmental Impact Statement

Chapter 4

Environmental Consequences

October 2015

4 ENVIRONMENTAL CONSEQUENCES

LIST OF TABLES

LIST OF FIGURES

4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Chapter 4 describes the potential impacts of the Proposed Project and the alternatives described in Chapter 2, Alternatives Analysis. The affected environment described in Chapter 3 serves as a baseline for determining the potential environmental consequences that are likely to occur from these proposed actions.

An impact analysis was conducted for each resource area described in Chapter 3 and comparisons were made between the Baseline Conditions (Baseline), Hall County's (Applicant's) Proposed Project, action alternatives, and the No Action Alternative. Within each resource area section of this chapter, a discussion of environmental consequences includes anticipated impacts, methodology and tools used for the impact analysis.

The level of impact is determined based on regulatory standards, criteria and ordinances, available studies and scientific documentation, and professional judgment of the Draft Environmental Impact Statement (DEIS) team. Based on the impact analyses, additional mitigation measures to minimize potential adverse impacts are identified in this chapter. The potential mitigation measures may or may not be included as conditions of a Section 404 permit or other state or local permits.

It is anticipated that the Applicant would implement certain environmental protection measures, consistent with current standards of practice, including design features and procedures to avoid or reduce adverse impacts of the action alternatives.

> An **environmental impact** is defined as a modification or change in the existing environment as a result of actions taken.
>
> Impacts may include social, economic, and environmental impacts. Impacts may be beneficial or adverse, may be assessed based on their duration, severity, or relation to the impacts from the Proposed Project, and may vary in severity from only a slight discernable impact to a major impact. (*40 Code of Federal Regulations [CFR] § 1508.7-1508.8*)

4.1.1 Types and Definitions of Impacts

The following summarizes the definitions of various types of impact:

Direct Impact: Impacts associated with the Proposed Project or action alternatives that would result from construction of facilities (e.g., dams, pipelines, pump stations, plants, and inundation by reservoirs).

Indirect Impact: Secondary or subsequent impacts of the Proposed Project that occur later in time or at a distance from the action. The primary indirect impacts would result from project-induced flow and quality changes to the streams and rivers in the affected area.

Short-term impacts: Impacts that generally occur during construction activities and are considered temporary. Short-term disturbances that can be restored (e.g., pipelines) or would cease upon completion of construction activities (e.g., construction noise).

Long-term impacts: Impacts created by construction or operational changes that are considered long-term or permanent, sometimes remaining for the life of the project (e.g., dams), or that might occur intermittently over the life of the project (e.g., reservoir inundation).

4.1.2 Level of Impact and Description

The level of impacts to the resource areas are defined as follows:

No change: Impact on the resource area is barely perceptible or not measureable or confined to a small area; or the extent of the impact is limited to a very small portion of the resource. Any positive or negative impacts would be negligible, amounting to no effective change.

Slightly adverse/slightly beneficial: Impact on the resource is perceptible and measurable, but would not have an appreciable effect on the resource. Impact may be localized; or its intensity is small but over a broader area. This also can refer to impacts with short duration and not recurring.

Adverse/beneficial: Impact is clearly detectable and would have an appreciable effect on the resource area. Moderate impacts can be caused by combination of impacts ranging from high intensity impacts over a smaller area to small to moderate impacts over a larger area. This also can occur with small to moderate impacts that are recurring over a period of years.

Substantially adverse/substantially beneficial: Impact would result in a highly noticeable influence on the resource area—generally over a broader geographic extent and/or recurring for many years.

4.2 Approach for Evaluating Impacts

All compiled alternatives carried forward for detailed analysis include several “common components”, including:

- Additional water conservation of 2.3 million gallons per day (mgd)
- Water purchase from Jackson County of 1.2 mgd
- Additional groundwater development in the county for a total of 4.7 mgd
- Use of Cedar Creek Reservoir (revised safe yield of 4.3 mgd)

The evaluation of potential impacts focuses on the water supply infrastructure components that vary between alternatives, including water supply reservoirs and associated water transmission systems and treatment options. Generally, the impact evaluation is organized based on reservoir sites, river water transmission systems, and reservoir water transmission systems.

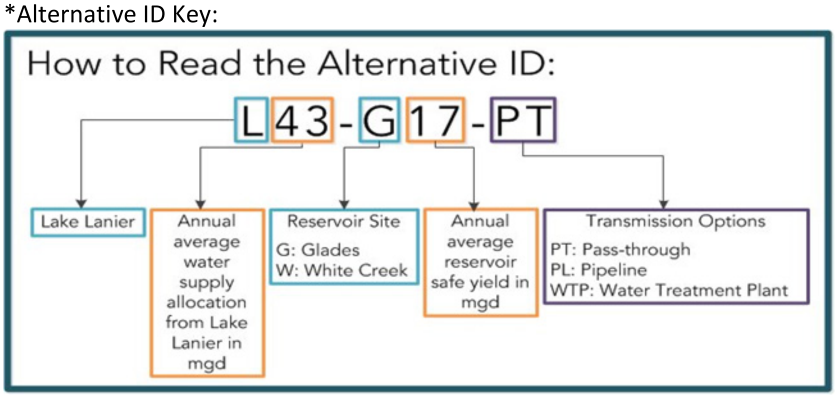
4.2.1 Summary of Alternatives Carried Forward for Impact Analysis

The alternatives identification, screening and analysis are presented in Chapter 2. **Table 4.1** provides a summary of the alternatives carried forward for detailed analysis in this chapter. A total of 13 alternatives are analyzed against the "Baseline Conditions". In addition to the Proposed Project and No Action Alternative, there are nine alternatives associated with Glades Reservoir (Alternatives 1-9) and two alternatives associated with White Creek Reservoir (Alternatives 10 and 11). Detailed descriptions of these alternatives are presented in Chapter 2. **Figure 4.1** shows the proposed Glades Reservoir site on Flat Creek in Hall County, while **Figure 4.2** shows the White Creek Reservoir site in White County, Georgia. The configuration of alternative transmission main and booster pump station are shown in **Appendix K**.

Table 4.1 Summary of Alternatives

Alternative #	Alternative ID*	Lake Lanier Allocation (mgd)	Reservoir Site	Reservoir Safe Yield (mgd)	River Water Transmission System (to reservoir)	Reservoir Water Transmission System (to Lakeside WTP)	Reservoir Water Transmission System (to New WTP)
Baseline	L18	18	N/A	N/A	N/A		
No Action	L60	60	N/A	N/A	N/A		
Proposed	L18-G50-PT	18	Glades	50	X		
1	L18-G42-PT				X		
2	L18-G42-PL	18	Glades	42	X	X	
3	L18-G42-WTP				X		X
4	L30-G30-PT				X		
5	L30-G30-PL	30	Glades	30	X	X	
6	L30-G30-WTP				X		X
7	L43-G17-PT				X		
8	L43-G17-PL	43	Glades	17	X	X	
9	L43-G17-WTP				X		X
10	L43-W17-PT	43	White	17	X		
11	L43-W17-PL				X	X	

N/A = Not Applicable
*Alternative ID Key:



4.2.2 Planning Horizon

A 50-year planning horizon is used by the Applicant and is in accordance with guidance for water supply reservoir planning in the *Georgia Comprehensive State-wide Water Management Plan* (January 2008, Section 10 Water Supply Management Practices). The U.S. Army Corps of Engineers (Corps) independently considered the planning horizon and concurred with the 50-year planning horizon for large water supply project. For this DEIS, the year 2060 is the planning horizon year for future conditions.

4.2.3 Alternative Implementation

The impact evaluation considers both short-term and long-term consequences of the Proposed Project and its alternatives. Therefore, the timing of construction (when the impact would occur) and the duration of impacts are considered based on construction logistics and potential phasing of water supply infrastructure component summarized in Chapter 2.

Implementation of the Proposed Project or its alternatives depends on the phased construction approach of water supply infrastructure components within each alternative. Design, land acquisition, and other local permitting applications will need to start several years before construction can begin. Implementation could begin as early as 2017 and could extend through 2058, depending on the phased construction of the alternatives (see Chapter 2).

Figure 4.1. Glades Reservoir Alternative Summary

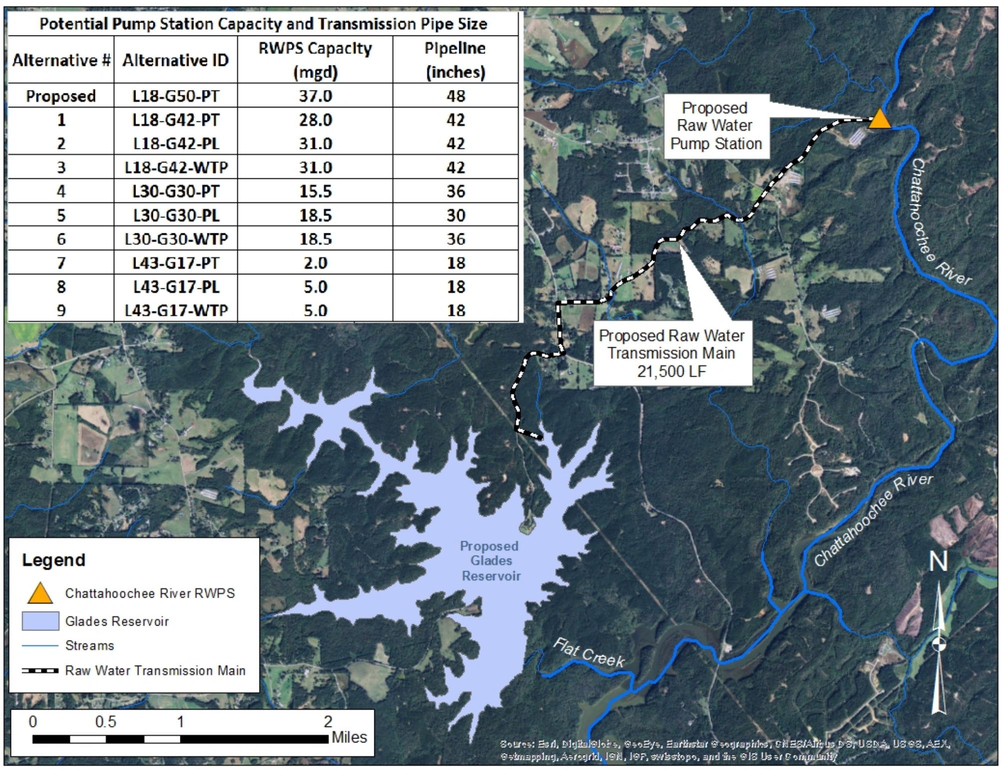
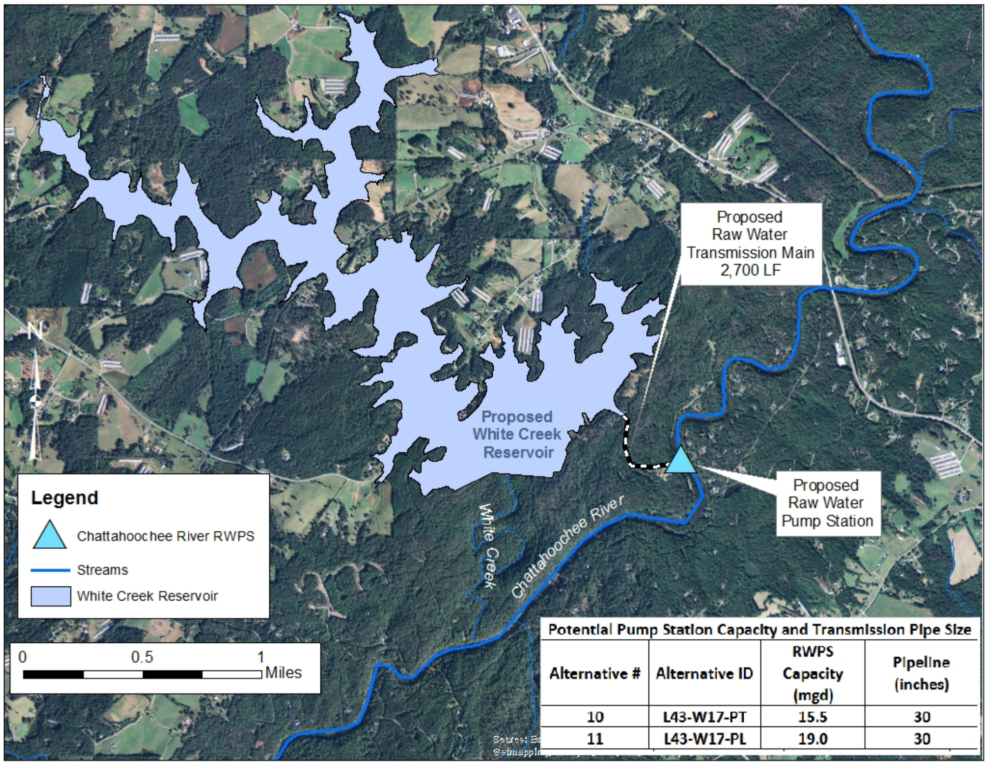


Figure 4.2 White Creek Reservoir Alternative Summary



Potential Pump Station Capacity and Transmission Pipe Size

Alternative #	Alternative ID	RWPS Capacity (mgd)	Pipeline (inches)
10	L43-W17-PT	15.5	30
11	L43-W17-PL	19.0	30

4.2.4 Baseline Conditions

The DEIS compares the potential project impacts against an "environmental baseline." The Baseline Conditions for this DEIS is defined as the year 2011 conditions. The year 2011 was selected as the "Baseline" based on the availability of critical data for the hydrologic model used to evaluate surface water resources impacts, and because it is a representative year for water use consumption (water use in 2011 was not affected by extreme hydrologic conditions such as drought or flood conditions). Additionally, the unimpaired flows used in the ACF RESSIM model to simulate hydrologic conditions are only available from 1939 through the year 2011.

Impacts to water resources and water-based resources (such as recreation and aquatic species) resulting from anticipated hydrologic changes are determined by comparing baseline (current) conditions and 2060 conditions. Hydrological modeling

ACF Basin WCM Update

Resolving Lake Lanier's water supply allocation will likely be a lengthy process with continuing controversy between Georgia and the downstream states of Alabama and Florida.

The Corps Mobile District prepared a DEIS for the update of its ACF River Basin Water Control Manual (WCM) concurrently as the Savannah District prepared this DEIS. As Hall County's current primary water supply source, a range of additional water supply withdrawal from Lake Lanier was considered in the alternatives analysis. This DEIS considers any additional water supply allocation for Hall County and water supply from the Glades Reservoir to be part of Georgia's 297 mgd water supply request for Lake Lanier (and part of the total 705 mgd request for the Chattahoochee Basin) based on the request the state of Georgia filed in January 2013.

plays a major role in this DEIS in determining the need for subsequent impact analysis for other resources. More information is provided in the Hydrologic Analysis section.

Impacts to land-based resources (such as land use, vegetation, and etc.) are evaluated for the Baseline Conditions and the 2060 conditions. Because land use data for 2011 is not available, the most recent publicly available land use data for the potential affected areas - the 2008 land use data from the Georgia Land Use Trends (GLUT) Project for the State of Georgia (generated by LANDSAT data) was used to represent the “Baseline.” Similarly, GLUT future land use for the State of Georgia is available only up to the year 2050. Therefore, the 2050 future land use is used to represent the potential 2060 conditions.

4.2.5 Key Assumptions for Impact Comparison

4.2.5.1 Lake Lanier Allocation and ACF Basin WCM Update

As discussed in Chapter 2, Lake Lanier allocation is an important component in the formulation of alternatives; the greater the total allocation, the less supply will be needed from alternative sources (for example, Glades or White Creek Reservoirs). The action alternatives are formulated based on four Lake Lanier allocation scenarios for Hall County water use: total allocations of 18, 30, 43, and 60 mgd, with 18 mgd being the current withdrawal level allowed by the Corps.

The Corps Mobile District is currently updating the Water Control Manual (WCM) for the Apalachicola-Chattahoochee-Flint (ACF) Basin and is evaluating Georgia’s January 11, 2013, water supply request for a total of 297 mgd (annual average withdrawal) from Lake Lanier and a total of 705 mgd (withdrawals from Lake Lanier and below Buford dam) for the metropolitan Atlanta area. It is unknown at this time what portion of the requested 297 mgd may be approved by the Corps Mobile District. It is also unknown what portion of the requested increase, if any, in water supply from Lake Lanier that Georgia Environmental Protection Division (EPD) may decide to allocate to Hall County. Therefore, it is not known whether Hall County’s water supply from Lake Lanier may be increased beyond its current withdrawal level (18 mgd annual average day [AAD]), or to the level currently permitted by EPD (30 mgd monthly average), or to the 60 mgd that would be needed for Hall County to meet its full projected 2060 demand, or possibly some other amount of between 18 and 60 mgd. In addition, it is unknown what kind of operational changes Mobile District may propose to coordinate the operation of upstream and downstream projects to meet the future water supply needs and other authorized purposes for the Corps reservoirs.

The Corps recognizes the uncertainty associated with the Lake Lanier allocation assumptions for this DEIS. This uncertainty affects all action and no-action alternatives, given the timing of the Applicant’s permit application and this DEIS process being concurrent to the Mobile District’s WCM update process. Despite the uncertainty, the Corps must use reasonable and consistent bases for the impact analysis. Therefore the hydrological modeling analysis for this DEIS includes the following key attributes:

- Using the same rule of operating the Corps’ ACF Basin reservoirs described in the Draft 1989 WCM, and

- Using the total water supply withdrawal quantity requested by the state of Georgia (297 mgd for Lake Lanier and 705 mgd for the Chattahoochee Basin) for evaluating cumulative effects in the ACF Basin for 2060 conditions.

This modeling approach is not intended to imply that the Savannah District expects that the Mobile District will grant all of Georgia's water supply request. This modeling approach simply allows the DEIS team to isolate the effect of the Proposed Project and its alternatives. For the cumulative effects analysis, there is no current basis for selecting a total withdrawal amount other than 705 mgd until the Mobile District releases the DEIS it is conducting for the ACF Basin WCM Update. The Mobile District will consider public comments received for the ACF Basin WCM Update DEIS as it prepares its Final EIS and record of decision. Therefore, the WCM Update will not be finalized and adopted for a period of time.

4.2.5.2 Glades Reservoir and Georgia's Water Supply Request

The impact evaluation is based on the assumption that the water supply withdrawal from Glades Reservoir (or its alternative) is considered part of the 297 mgd request for the Lake Lanier withdrawal request by the state of Georgia. This condition is based on the descriptions in Georgia's water supply request in January 2013. This assumption is critical in how the hydrological modeling is set up to evaluate downstream impacts.

4.2.5.3 No Action Alternative

In this DEIS *"no action"* means *"no proposed Glades Reservoir project" or* no permit approval from the Corps for the Proposed Project (see Chapter 2 for detailed descriptions for the No Action Alternative). For this DEIS, the "No Action Alternative" considers what Hall County would do to meet its water supply needs if it does not obtain a Section 404 permit for the construction of a new surface water supply source. The resulting environmental effects from taking no action are compared with the effects of permitting the proposed Glades Reservoir project or an alternative activity (action alternative).

No Action Alternative

In the event that a CWA Section 404 permit for the proposed Glades project is not issued, Hall County has indicated that it would need to meet its future demand through its existing water supply sources. Hall County asserts that they would have no choice but to rely on pursuing additional withdrawals of water from Lake Lanier, up to the amount needed to their full future (2060) water demands.

Although the City of Gainesville holds a withdrawal permit of 30 mgd (monthly average) from Lake Lanier issued by EPD, the Corps currently only allows Gainesville withdrawing up to 18 mgd provided it returns 10 mgd of treated effluent to Lake Lanier (see detailed description in text box in Section 1.6.2).

A new storage contract with the Corps will be required for withdrawals in excess of 18 mgd. A "potential future" agreement will be needed based on the ultimate quantity of water Georgia will be able to withdraw from Lake Lanier and this quantity will not be final until the Corps Mobile Districts completes and adopts its WCM Update for the ACF Basin. It is most likely that the Corps Mobile District will issue one new storage contract to the state of Georgia. The Georgia EPD would then allocate water supplies to entities through its withdrawal permit system. Potential challenges to the WCM Update EIS and its provisions for future water management operations could cause further delays in both federal and state permits allowing additional Lake Lanier water withdrawals.

Detailed descriptions of the No Action Alternative can be found in Chapter 2.

4.2.5.4 Types of Impact Comparisons

Various types of impact comparison are needed to understand the different kinds of impacts and the causes of the impacts:

- Comparison between all alternatives (2060 conditions) against the Baseline Conditions (2011 conditions and without reservoir) is done to determine the impacts from the Proposed Project and its alternatives and from the anticipated increase in basin-wide demands from the 2011 condition to the 2060 condition (cumulative effects comparison). It is important to separate the effects between the Proposed Project's direct and cumulative effects.
- Comparison between the action and No Action Alternatives are done to isolate the effects of the Proposed Project and its alternatives.

- Comparisons are done among groups of action alternatives to isolate the effect of certain water supply components. For example, comparisons were done for alternatives with the same Lake Lanier allocation quantity and reservoir yield to compare the impacts of various transmission scenarios (for example, Alternatives 1-3, 4-6, and 7-9). Alternatives with the same transmission scenarios are also compared to isolate the effects of various Lake Lanier allocation quantities and reservoir combinations.

4.3 Surface Water Management and Assessment

This section focuses on impacts of the Proposed Project and its alternatives on surface water hydrology. Issues related to surface water resources were raised during the public scoping process and are described in Chapter 1 and the Public Scoping Summary Report. The changes to the surface water hydrology are identified and this evaluation will be used to determine the environmental and socioeconomic consequences of other resource areas. Impacts to surface water quality will be discussed in the next section.

The evaluation of impacts to surface water resources is organized into two parts:

- Direct Impacts to Streamflow Upstream of Lake Lanier, and
- Indirect Impacts to the Entire ACF Basin

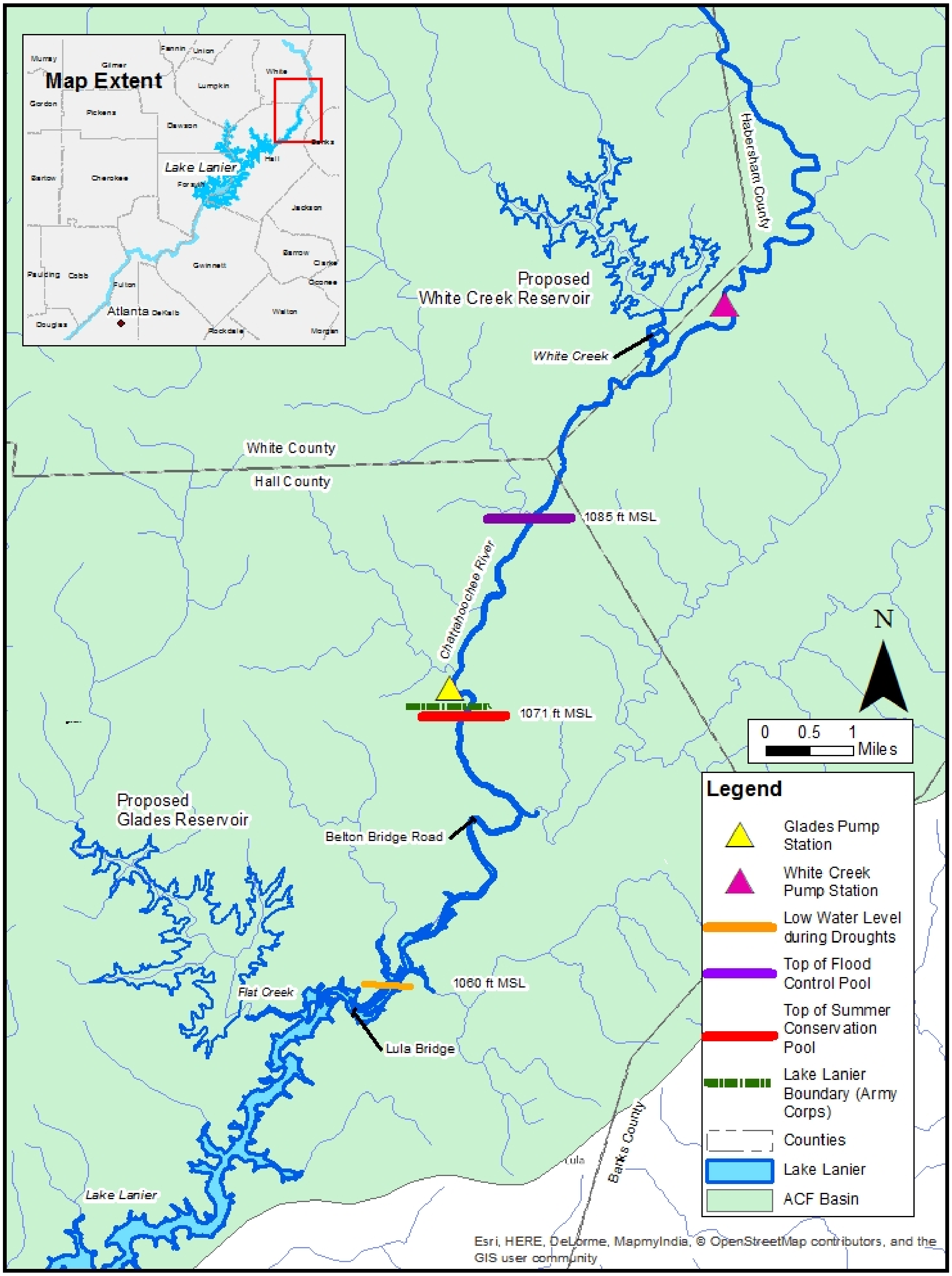
Figure 4.3 shows the proposed reservoir sites (Glades and White Creek Reservoir) in relation to the ACF Basin. All of the water supply infrastructure components for the Proposed Project and its alternatives are located upstream of Lake Lanier. The impacts to streamflows upstream of Lake Lanier are evaluated with a spreadsheet based model (safe yield analysis model). The downstream impacts to the ACF Basin, including impacts to streamflow, reservoir water surface elevation, reservoir discharge, hydropower operations, recreation, drought operations, and navigation, are evaluated with a hydrologic model for the ACF Basin.

Figure 4.4 shows how far upstream the water level fluctuations from Lake Lanier can affect the Chattahoochee River and the tributaries above Lake Lanier property boundary. The Corps' property boundary is located just upstream of Lake Lanier's top of summer conservation pool level (1071 feet mean sea level [ft MSL]). The Chattahoochee River intake for Glades Reservoir is located approximately 0.5 miles upstream of the Corps' property boundary for Lake Lanier. Flat Creek and the proposed Glades Dam are downstream the normal pool level of Lake Lanier and will be under lake influence most of the time. Even at low water level during drought (around 1060 ft MSL), Flat Creek will be under lake influence.

The Chattahoochee River intake for the White Creek Reservoir is approximately 5.9 miles above the 1071 ft MSL summer pool level of Lake Lanier and is approximately 3.4 miles upstream of the 1085 ft MSL flood pool level. This part of the Chattahoochee River will not be influenced by Lake Lanier.

Figure 4.3 Surface Water Hydrologic Analysis Direct and Indirect Impact Areas

Figure 4.4 Lake Lanier Pool Level Influence on Proposed Water Supply Infrastructure Components



4.3.1 Instream Flow Protection

Instream flow is needed to protect aquatic habitat and downstream users such as fish, wildlife, recreation, public water supply, and water quality (*see the Instream Flow Protection Threshold sidebar*). The Georgia EPD regulates the instream flow and implements its instream flow protection policy through provisions contained in surface water withdrawal permits (*see 'Georgia Instream Flow Policy textbox*). This section provides a brief summary of Georgia's existing instream flow policy, agency coordination efforts, and the analyses conducted to evaluate potential instream flow requirement below the proposed pump station on the Chattahoochee River to minimize potential impacts downstream.

Instream Flow Protection Threshold (IFPT)

IFPT is used throughout this DEIS to express the minimum instream flow level required to protect water quality and a healthy aquatic environment, which is the purpose of instream flow management. The Applicant used the more conventional term "minimum instream flow" (MIF) in its surface water withdrawal application. Georgia EPD currently prefers the use of the term IFPT.

In addition to the 404 permit application, the Applicant submitted a water withdrawal permit application to the Georgia EPD in May 2011. As part of the water withdrawal permit application, the Applicant submitted an "Alternative Minimum Instream Flow" request for the flow below the Glades Reservoir raw water intake on the Chattahoochee River and for the release below Glades Reservoir. Based on a site-specific study, the Applicant requested that the A7Q10 flow (*see 7Q10 Flow Definitions sidebar*) be approved as the minimum instream flow (referred to as IFPT in this DEIS) below the proposed Glades Reservoir raw water intake on the Chattahoochee River and for the release below Glades Reservoir.

4.3.1.1 Agency Review and Coordination

During a coordination meeting held by the Corps, the Georgia EPD, and Hall County representatives on May 31, 2012, the Georgia Department of Natural Resources (GDNR) Wildlife Resources Division (WRD) staff commented that they had concerns related to the completeness and conclusions of the Applicant's site-specific study for requesting an A7Q10 IFPT at the Chattahoochee River intake.

7Q10 Flow Definitions

A stream's **7Q10** is a statistical figure that reflects the lowest 7-day running average of a stream's flow with a recurrence frequency of once in ten years.

The **A7Q10 flow** is the annual minimum 7-day running average flow with a recurrence frequency of once in 10 years.

The **M7Q10 flow** reflects the lowest 7-day running average of a stream's flow for each calendar month with a recurrence frequency of once in ten years.

A summary of the WRD's comments are provided below:

- Analysis should be performed to evaluate the impacts to fisheries under various flow scenarios that incorporate the potential for reduced flows (including A7Q10 and M7Q10 flows).
- Impacts to game fish species (including those species that normally live in Lake Lanier, but enter the Chattahoochee River to spawn) should be assessed.
- Impacts to recreational boaters/anglers should be assessed.

Georgia Instream Flow Policy

The State of Georgia adopted its "Interim Instream Flow Policy" on April 1, 2001, (Water Issues White Paper, Georgia's Interim Instream Flow Policy, Board of Natural Resources, State of Georgia, May 2001). Prior to 2001, the annual 7Q10 (A7Q10) (*see 7Q10 Flow Definition sidebar*) was used as the basis to calculate needed stream flows for water quality standards or wasteload assimilation purposes. Since the adoption of the Interim Instream Flow Policy, applicants seeking water withdrawal permit can select one of the following three options for determining the IFPT:

1. Monthly 7Q10 (M7Q10) flow
2. Site-specific instream flow study
3. Mean annual flow
    - 30% of mean annual average flow (direct withdrawal; no impoundment)
    - Seasonal 30/60/40% of mean annual flow (water supply reservoir)

These options are thought to provide generally better protection of aquatic life than the A7Q10 flow used before the adoption of the Interim Instream Flow Policy. These options provide seasonal variations (M7Q10 or the 30/60/40%) that mimic the natural variations in streams, or site-specific evaluation of minimum flow conditions for protection of aquatic habitat. Applicants for water withdrawal can choose to conduct a site-specific instream flow study if the study design and scope is pre-approved by GDNR. The mean annual flow option allows for 30% of the mean annual average flow to be used as an IFPT for direct withdrawal (no impoundment). If the IFPT is being calculated for a water supply reservoir, then 30/60/40% mean annual flow is to be used (30% July through November, 60% January through April and 40% May, June and December).

Based on agency comments and subsequent discussions with the GDNR EPD and WRD, the Corps determined that additional evaluations to supplement the site-specific study were required to better understand the IFPT options and associated impacts to recreation and aquatic habitat below the proposed intake on the Chattahoochee River.

The DEIS team worked with WRD to define the scope for the supplementary field survey and subsequently conducted additional field survey and habitat modeling to supplement the initial site-specific study for the determination of the appropriate IFPT below the Chattahoochee River intake. Multiple flow scenarios were analyzed to represent a range of flows including 5% annual average daily flow (AADF), 30% AADF, average monthly flows (AMF) for January through December, monthly 7Q10 (M7Q10) flows for January through December, 30% AADF for the spring seasonal flow (from February through May), and the AADF. The range of flow scenarios covers the expected extremes of potential flows within the study area that were used to evaluate impacts to fishing and boating. Three technical memorandums were developed for this site-specific study and can be found in **Appendix O**.

4.3.1.2 Glades Reservoir Intake IFPT

The site-specific study (**Appendix O**) concluded that the although A7Q10 (154 cubic feet per second [cfs]) is sufficient to support the year-round habitat quality and quantity of resident game fish species and springtime spawning migration of transient game fish species, A7Q10 is insufficient to support access by recreational anglers to the upper reaches of the Chattahoochee River during the spring spawning run, and transient game fish species would experience moderate losses of suitable habitat area at this flow. A flow of 30% AADF during the spring months of February through May would mitigate the moderate losses of suitable habitat for transient game fish species and limitations on angler access during this period. Based on the detailed habitat analysis using the U.S. Geological Survey (USGS) Physical Habitat Simulation System (PHABSIM) model and a low-flow analysis, a 2-stage IFPT scenario was recommended. **Table 4.2** summarizes the proposed 2-stage IFPT flows. The proposed scenario sets the IFPT equal to 30% AADF (276 cfs) during the spring months of February through May, and equal to the A7Q10 (154 cfs) during the remaining months.

Table 4.2 Proposed 2-Stage IFPT at Chattahoochee River Intake for Glades Reservoir[1,2]

Month	IFPT (cfs)
February - May (30% AADF)	276
June - January (A7Q10 ~ 17% AADF)	154

1 Period of record analyzed: January 1, 1958 through December 31, 2012.
2 Based on an observed AADF of 922 cfs from the flow at the proposed intake location, which was calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

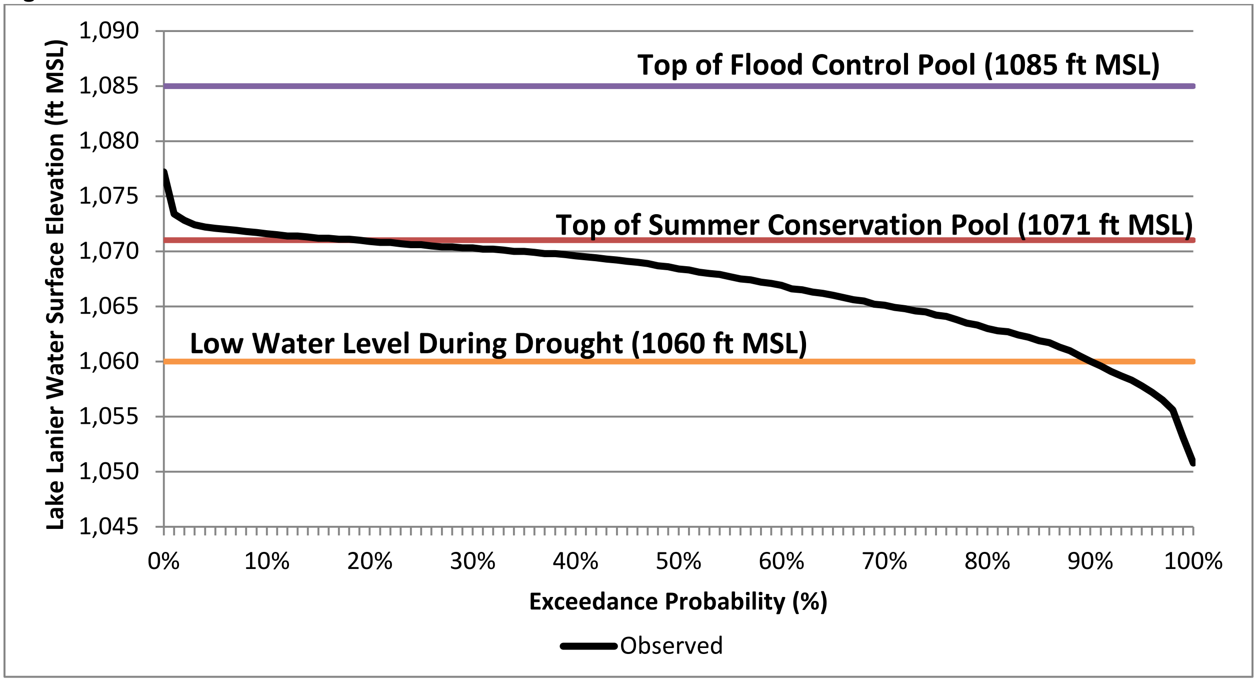
The proposed 2-Stage IFPT value was calculated as part of a site-specific study and is only applicable for the Glades Reservoir intake location (approximately 1.5 miles upstream from Belton Bridge).

4.3.1.3 Flat Creek IFPT

For the IFPT below the proposed Glades Dam, the Applicant proposed an A7Q10 value of 4.6 cfs for Flat Creek below the dam (calculated using a drainage area ratio conversion using USGS 02334885 Suwanee Creek at Suwanee, GA from 10/1/1984-3/25/2010). The Applicant's rationale is that Flat Creek is under the influence of Lake Lanier backwater (as shown in **Figure 4.4**) and because of this, a release of A7Q10 is sufficient to maintain the habitat in the lake-like creek. This rationale and value were accepted and approved by the Georgia EPD (March 2013).

The Corps conducted an independent evaluation on the effects of Lake Lanier backwater at Flat Creek and on the Chattahoochee River. **Figure 4.5** shows the percent duration of Lake Lanier's water level fluctuations for the observed period from 1959 through 2012. Flat Creek, which is located 1.4 miles downstream of the low lake level (1060 ft MSL) is under lake level influence 90.5% of the time (the percent of time the Lake Level has been above 1060 ft MSL). This confirms that Flat Creek is under the influence of Lake Lanier backwater and because of this, a release of A7Q10 is sufficient to maintain the habitat in the lake-like creek.

Figure 4.5 Historic Lake Lanier Water Level Duration Curve[1,2]



1 Period of Record Analyzed: January 1, 1959 through December 31, 2012.

2 Lake Lanier recorded water surface elevations downloaded from the Corps Mobile District Water Management Section webpage (http://water.sam.usace.army.mil/).

4.3.1.4 White Creek Reservoir Intake IFPT

The Chattahoochee River intake for the White Creek Reservoir is approximately 6 miles above the 1071 ft MSL summer pool level of Lake Lanier and is approximately 3 miles upstream of the 1085 ft MSL flood pool level. **Figure 4.5** shows that Lake Lanier exceeds the top of the summer conservation pool (1071 ft MSL) approximately 21.5% of the time, and has never reached the top of the flood control pool (1085 ft MSL). Because the proposed Chattahoochee River intake for the White Creek Reservoir is upstream of Lake Lanier's top of flood pool level, this segment of upper Chattahoochee River and tributaries will not be influenced by lake level fluctuations (definitely river characteristics). The M7Q10 flows were used for IFPT for the proposed river intake location as summarized in **Table 4.3.** A site-specific study is not required for this intake location as long as one of the three options stated in the Georgia's Interim Instream Flow policy is used to determine the IFPT. Unless the Applicant wishes to justify an IFPT other than M7Q10 flows, a site-specific study is not currently planned for the intake location for the White Creek Reservoir.

Table 4.3 Proposed IFPT at White Creek Reservoir Chattahoochee River Intake[1]

Month	M7Q10 IFPT[2]
January	356.7
February	398.8
March	468.3
April	446.3
May	340.3
June	235.0
July	215.7
August	159.9
September	161.1
October	173.6
November	211.5
December	253.2

[1] Period of record analyzed: January 1, 1958 through December 31, 2012.
[2] The flows in Chattahoochee River at proposed intake location were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

4.3.1.5 White Creek IFPT

White Creek will not be influenced by Lake Lanier pool level fluctuations (definitely river characteristics). The M7Q10 flows were used for the IFPT below the White Creek Dam, as summarized in **Table 4.4.** Similarly, a site-specific study is not required unless the Applicant wishes to justify an IFPT other than M7Q10 flows.

Table 4.4 Proposed IFPT at Below Dam on White Creek[1]

Month	M7Q10 IFPT[2]
January	5.4
February	6.1
March	6.6
April	5.8
May	3.3
June	1.5
July	0.7
August	0.6
September	0.8
October	0.9
November	2.4
December	3.5

[1] Period of record analyzed: January 1, 1958 through December 31, 2012.
[2] The flows in White Creek at proposed dam site were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwanee, GA.

4.3.2 Direct Impact to Streamflow Upstream of Lake Lanier

This section discusses the flow alteration anticipated upstream of Lake Lanier as a direct result of the Proposed Project and its alternatives. The impacts of the alternatives to the Chattahoochee River, to Flat Creek or White Creek (where the proposed dam will be built), and to the inflow to Lake Lanier are evaluated with a spreadsheet based safe yield analysis model.

4.3.2.1 Methodology

A spreadsheet based model was used to evaluate the reservoir safe yield and the streamflow impacts from each alternative. The safe yield analysis model uses a water balance concept to calculate the change in reservoir storage and streamflow on a daily basis. The analysis is based on historical daily streamflow and net evaporation data. The storage at the end of the day is equal to inflows (natural and pumped streamflow) minus outflows (water supply withdrawals, net evaporation, IFPT release below dam etc.).

Each alternative was evaluated with the safe yield analysis model to determine the amount of pumping from the Chattahoochee River necessary to maintain the safe yield of Glades or White Creek Reservoir. The following are general operating conditions for pumping from the Chattahoochee River to the reservoir alternatives for all of the action alternatives:

- Pumping from the Chattahoochee River to fill or refill the reservoir is only allowed when the Chattahoochee River flow exceeds the IFPT at the intake
- If the natural streamflow is less than the IFPT, no pumping is allowed
- Pumping stops when the water level in the reservoir reaches the normal pool water surface elevation

The operating conditions for releases from Glades and White Creek Reservoir depend on the transmission scenario of the alternative. When the water supply for Hall County is released into Flat Creek or White Creek to pass-through Lake Lanier (the PT scenario), the IFPT flow is automatically met by the water supply release, as the water supply release is always higher than the IFPT value for the creek. When the water supply is pumped directly from the reservoir to Lakeside WTP (PL scenario) or a new WTP near the reservoir (WTP scenario), an IFPT flow is maintained downstream of the dam in Flat Creek or White Creek. This IFPT is independent of the water supply quantity pumped to the WTP. The following are the general rules for operation of water releases to the tributary for all of the action alternatives:

- At all times, the IFPT or the natural streamflow into the reservoir – whichever is less - is maintained below the dam.
- When the reservoir is full and the IFPT is met, any excess natural streamflow into the reservoir is spilled to the tributary to maintain pool level at the normal pool level.

The model simulated daily flows at the intake location before and after pumping, the pumping of raw water from the Chattahoochee River, the streamflow into and out of the reservoirs (from Flat and White Creek), and the resulting Chattahoochee River flow into Lake Lanier. The model uses 74 years of daily flow data from January 1, 1939 through December 31, 2012. **Appendix M** provides detailed descriptions of the model and the analysis.

A daily time step is selected as the basis for analysis for multiple reasons, most importantly, the daily time step for the safe yield and streamflow analysis is consistent with the daily time step used for hydrological modeling for downstream impact analysis for the entire ACF Basin. In addition, daily flows are available for an extended period from USGS that covers multiple historical drought periods. It is important to point out that the release of water supply volume from the reservoir and the withdrawal of raw water at the WTP intake will be a continuous operation over a 24-hour period. The pumping rate at the river intake and at the WTP intake may vary from hour to hour depending on the availability of the river flow, reservoir filling need, treatment need, and peak and off-peak power costs. The operation of a treatment and distribution system is dependent on the demand of the system (usage from the customers) and fluctuates based on the available finished water storage in the system. Finished water can be stored in clearwells at the WTP, or ground or elevated storage tanks in the distribution system to balance the immediate need of the system. Hall County and Gainesville will have flexibility in operating their raw water storage, treatment and distribution system in an optimal and efficient manner.

To consider seasonal water use trend, a monthly peaking demand factor is applied for each month of the year to simulate higher system demand in summer/fall months and lower demand in winter months. The monthly peaking factors were calculated based on actual plant treatment and production data from Gainesville PUD by comparing monthly to annual average water production quantity. This monthly peaking factor is applied to the water supply release (or withdrawal) from the reservoir.

4.3.3 Upstream Flow Alteration

The Baseline Conditions and the No Action Alternative evaluate streamflow conditions without a project; upstream of Lake Lanier the conditions for these two are identical. The Baseline Conditions for Flat Creek and White Creek and for respective intake locations on the Chattahoochee River are established for comparison with the respective Glades or White Creek Reservoir alternatives. However, because Baseline Conditions are different for Glades and White Creek Alternatives (due to location difference), comparison would require a No Action Alternative for Glades Reservoir and for White Creek Reservoir, respectively. For simplification, the upstream alternatives are only compared to the Baseline Conditions and for the differences amongst the alternatives.

4.3.3.1 Flow Alteration at Chattahoochee River Intake Locations

This section discusses the anticipated flow alteration due to pumping in the Chattahoochee River at the proposed intake locations for Glades and White Creek Reservoirs.

Higher average pumping quantity and larger intake and pump station capacity are needed to achieve a higher safe yield in the reservoir. **Table 4.5** summarizes the required Chattahoochee River intake capacity (on a maximum daily basis) for each alternative, and the average pumping quantity. The Proposed Project (L18-G50-PT) requires an average pumping rate of 34 mgd in order to achieve a 50-mgd safe yield for Glades Reservoir.

The alternatives with PL and WTP transmission options require more pumping from the Chattahoochee River than the alternatives for the same reservoir yield with the PT transmission option. This is because the PL and WTP transmission options must release IFPT flows downstream of the dams in addition to the water supply that is pumped directly from the reservoirs. The water supply releases from the dam in the PT transmission scenarios meet the IFPT requirements, therefore they require less pumping from the Chattahoochee River to obtain the same safe yield. For example, Alternative 1 (L18-G42-PT) requires an average pumping of 26 mgd, while Alternative 2 (L18-G42-PL) and Alternative 3 (L18-G42-WTP) require an average pumping of 29 mgd in order to achieve a 42-mgd safe yield for Glades Reservoir and to maintain the required IFPT below the dam.

Table 4.5 Chattahoochee River Intake Pump Station Capacity and Annual Average Pumping Quantities

Alternative #	Alternative ID	Reservoir Safe Yield[1] (AAD, mgd)	Chattahoochee River Intake & PS Capacity[2] (mgd)	Average Pumping[1] (mgd)
Baseline- Glades[3]	L18	---	---	---
Proposed	L18-G50-PT	50	37.0	34.2
1	L18-G42-PT	42	28.0	26.1
2	L18-G42-PL	42	31.0	29.0
3	L18-G42-WTP	42	31.0	29.0
4	L30-G30-PT	30	15.5	14.3
5	L30-G30-PL	30	18.5	17.2
6	L30-G30-WTP	30	18.5	17.2
7	L43-G17-PT	17	2.0	1.8
8	L43-G17-PL	17	5.0	4.6
9	L43-G17-WTP	17	5.0	4.6
Baseline- White Creek[4]	L18	---	---	---
10	L43-W17-PT	17	15.5	9.8
11	L43-W17-PL	17	19.0	11.6
No Action[5]	L60	---	---	---

[1] Period of analysis: January 1, 1939 through December 31, 2012.
[2] Pump station and intake capacity is sized and expressed based on maximum daily demand.
[3] The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[4] The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).
[5] The No Action Alternative evaluates the 2060 conditions without a project.

Table 4.6 shows the range of daily flow in the Chattahoochee River without the reservoirs (Baseline and No Action), and with the reservoirs at the Glades Reservoir intake (Proposed Project and Alternatives 1-9), and at the White Creek Reservoir intakes (Alternatives 10-11). The average daily and maximum daily flow is reduced from Baseline Conditions for all alternatives. However, because no pumping is allowed when the flow is less than the IFPT, the minimum daily flows remain the same.

Table 4.6 Estimated Daily Average, Minimum, and Maximum Flow (cfs) at the Chattahoochee River Intake Locations with and Without a Project[1]

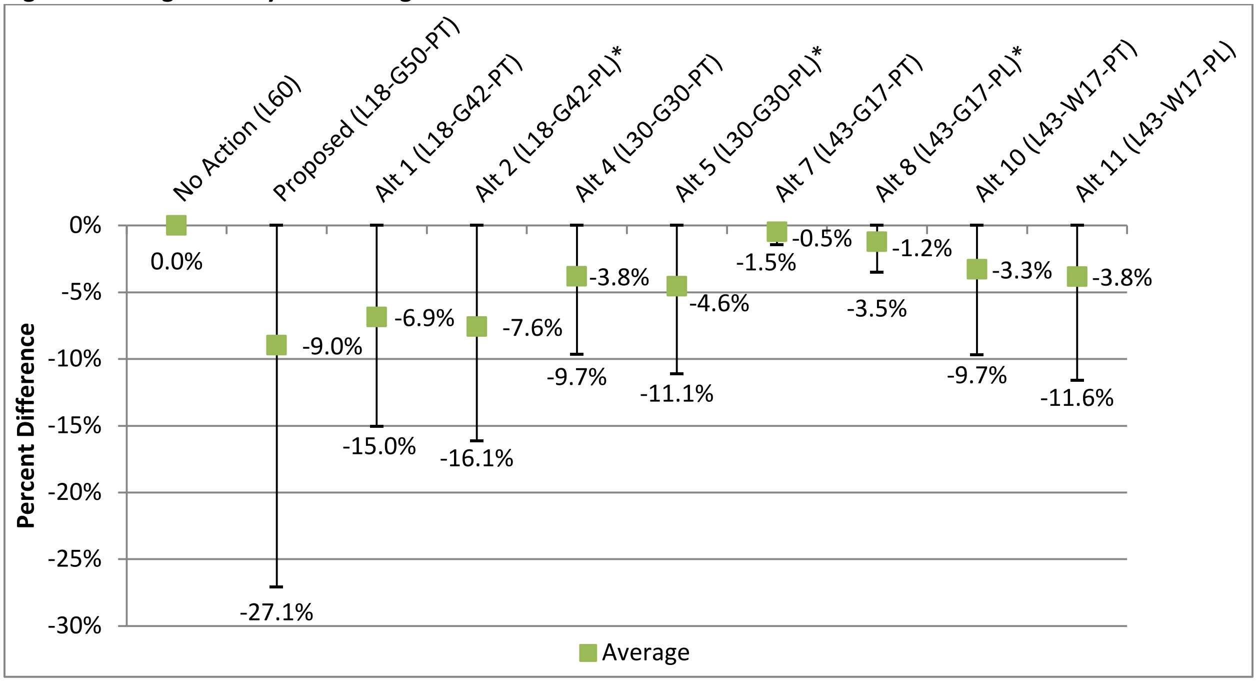
Alternative #	Alternative ID	Average Daily	Minimum Daily	Maximum Daily
Baseline- Glades[2,3]	L18	903	78	18,759
Proposed	L18-G50-PT	850	78	18,702
1	L18-G42-PT	863	78	18,716
2	L18-G42-PL	858	78	18,711
3	L18-G42-WTP	858	78	18,711
4	L30-G30-PT	881	78	18,735
5	L30-G30-PL	876	78	18,730
6	L30-G30-WTP	876	78	18,730
7	L43-G17-PT	900	78	18,756
8	L43-G17-PL	896	78	18,751
9	L43-G17-WTP	896	78	18,751
Baseline- White Creek[2,4]	L18	770	67	15,988
10	L43-W17-PT	754	67	15,985
11	L43-W17-PL	752	67	15,988
No Action[5]	L60	NC[6]	NC[6]	NC[6]

[1] Period of analysis: January 1, 1939 through December 31, 2011.
[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.
[3] The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[4] The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).
[5] The No Action Alternative evaluates the 2060 conditions without a project.
[6] NC = No Change of flow statistics from Baseline at the respective intake location for the two reservoir sites.

The percent difference in flows below the intake with and without the reservoir is dependent on the average pumping volume. **Figure 4.6** shows the range of the anticipated reduction of the daily flow compared to the Baseline Conditions (without pumping) and the average % reduction. Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size. On a daily basis, the flow reduction at the Glades intake on the Chattahoochee River for the Proposed Project is estimated to range from 0% to 27.1% and average 9.0%. The other Glades Reservoir alternatives require a smaller diversion from the Chattahoochee River for smaller safe yield targets, and therefore the estimated average reduction of flow ranges from 0.5% (Alternative 7) to 7.6% (Alternatives 2 and 3). Alternatives 10 and 11 are estimated to reduce the daily flow at the White Creek intake on the Chattahoochee River by an average of 3.3% and 3.8%, respectively.

Draft Environmental Impact Statement

Figure 4.6 Range of Daily Flow Change at the Chattahoochee River Intake Locations[1,2,3]



* Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size.

1 Period of analysis: January 1, 1939 through December 31, 2012.

2 The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).

3 The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).

Table 4.7 summarizes the duration (in percent of time) and magnitude (percent reduction of baseline flow) that the daily flow is reduced for the Proposed Project and its alternatives. The time when there would be no (0%) flow reduction ranges from 2.6% of time for Alternatives 2 and 3 to 16.8% of time for Alternative 10 (for the period 1939-2012 analyzed). For the Proposed Project (L18-G50-PT), the flow would be reduced by less than 5% for 23% of the time, by 5% to 10% for 39% of the time, and by 10% to 20% for 30% of the time. The alternatives with a smaller reservoir yield size require less pumping from the Chattahoochee River, therefore the magnitude of the flow reduction is less, and the duration of the flow reduction is also shorter.

Table 4.7 Duration (in Percent of Time) and Magnitude (Percent Change from Baseline) of the Daily Flow Change at the Chattahoochee River Intake[1]

Alternative #	Alternative ID	0% Flow Reduction	0% to 5% Flow Reduction	5% to 10% Flow Reduction	10% to 20% Flow Reduction	20% to 25% Flow Reduction	> 25% Flow Reduction
Baseline-Glades[2]	L18	---	---	---	---	---	---
Proposed	L18-G50-PT	2.7%	22.8%	39.0%	30.1%	4.5%	1.0%
1	L18-G42-PT	2.9%	36.0%	40.8%	19.3%	1.0%	0.0%
2	L18-G42-PL	2.6%	30.5%	41.8%	23.1%	2.0%	0.0%
3	L18-G42-WTP	2.6%	30.5%	41.8%	23.1%	2.0%	0.0%
4	L30-G30-PT	4.5%	70.1%	22.9%	2.5%	0.0%	0.0%
5	L30-G30-PL	3.9%	60.3%	29.7%	6.0%	0.0%	0.0%
6	L30-G30-WTP	3.9%	60.3%	29.7%	6.0%	0.0%	0.0%
7	L43-G17-PT	10.0%	90.0%	0.0%	0.0%	0.0%	0.0%
8	L43-G17-PL	7.8%	92.2%	0.0%	0.0%	0.0%	0.0%
9	L43-G17-WTP	7.8%	92.2%	0.0%	0.0%	0.0%	0.0%
Baseline-White Ck[3]	L18	---	---	---	---	---	---
10	L43-W17-PT	16.8%	56.9%	23.7%	2.7%	0.0%	0.0%
11	L43-W17-PL	13.8%	55.7%	24.5%	6.1%	0.0%	0.0%
No Action[4]	L60	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[1] Period of analysis: January 1, 1939 through December 31, 2012.
[2] The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[3] The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).
[4] The No Action Alternative evaluates the 2060 conditions without a project.

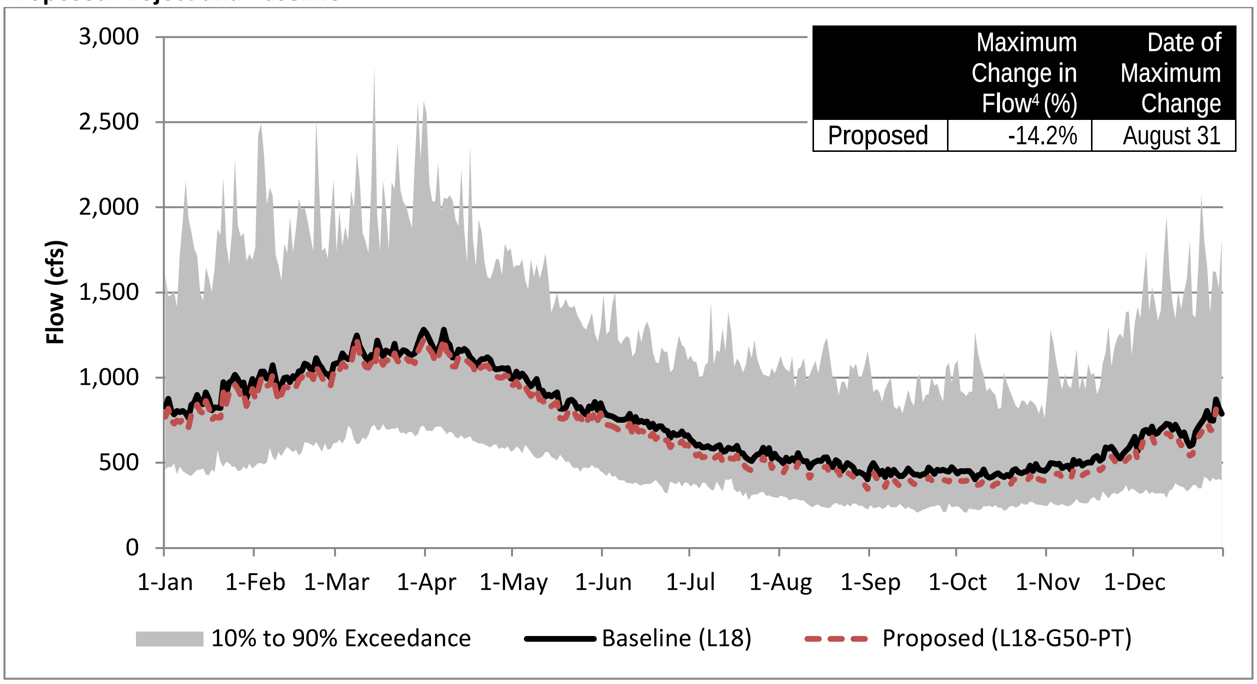
Glades Reservoir Alternatives

Figure 4.7 compares the average daily flow at the Chattahoochee River intake for the Proposed Project (L18-G50-PT) against the Baseline Conditions (L18). The average daily flow was calculated for each day of the year based on daily flows over the 73-year period of record analyzed (1939 to 2011). The shaded gray area shows the 10% to 90% exceedance flow range, which represents the natural variation of the daily baseline flow. The baseline flow is higher than the top of the gray area for only 10% of the time and the baseline flow is lower than the bottom range of the gray area for only 10% of the time.

The Proposed Project would reduce the average daily flow (from Baseline Conditions) at the Chattahoochee River intake with the average calculated based on the flow for each day of the 73-year of record analyzed (

Figure 4.7). The largest deviation from the average daily baseline flow is -14.2%, which occurs on August 31st. The Proposed Project would be the alternative with the highest variance from the Baseline streamflow because the Proposed Project requires the highest pumping from the river as compared to other action alternatives. Even so, the streamflow below the intake with the Proposed Project in operation is still within the natural range of baseline flow without the reservoir.

Figure 4.7 Average Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of the Proposed Project and Baseline[1, 2,3]



1 Period of analysis: January 1, 1939 through December 31, 2011.

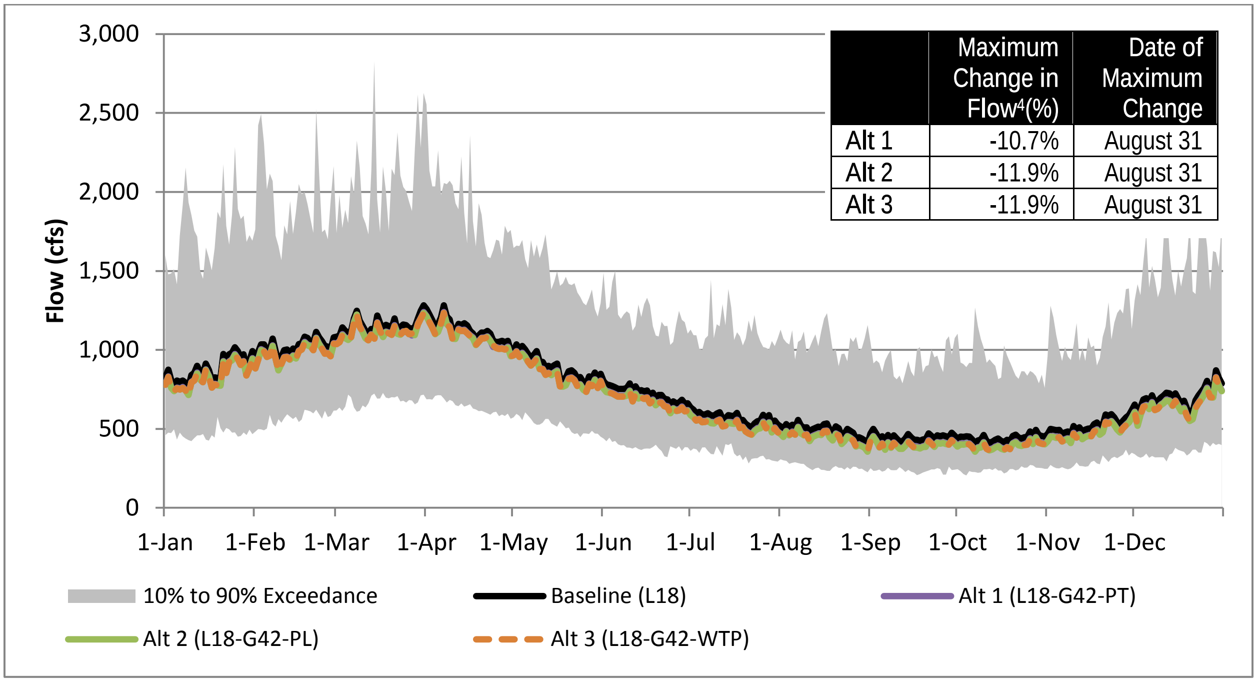
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

3 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

4 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.8 compares the average daily flow at the Chattahoochee river intake for Glades Reservoir for Alternatives 1 to 3 and the Baseline Conditions (L18). The Glades Alternatives with a yield of 42 mgd would result in maximum reduction in average daily flow of 10.7% to 11.9% on August 31^{st}.

Figure 4.8 Average Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 1-3 and Baseline[1, 2,3]



	Maximum Change in Flow[4](%)	Date of Maximum Change
Alt 1	-10.7%	August 31
Alt 2	-11.9%	August 31
Alt 3	-11.9%	August 31

1 Period of analysis: January 1, 1939 through December 31, 2011.

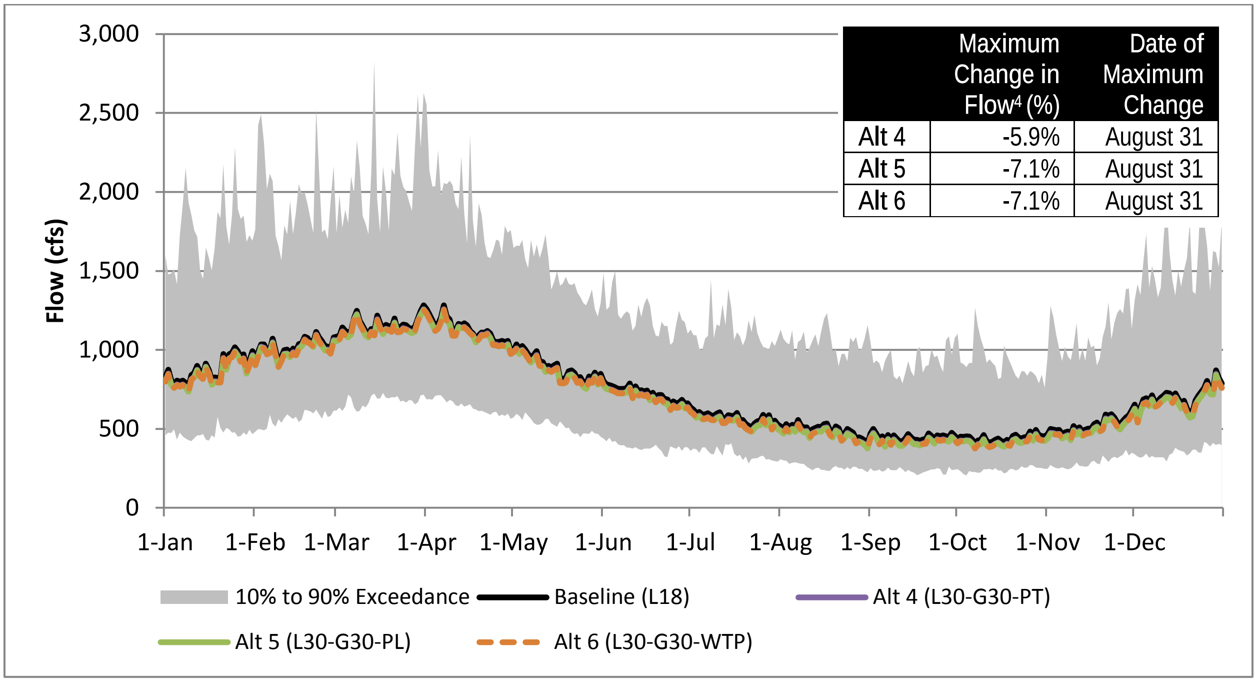
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

3 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

4 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.9 compares the average daily flow at the Chattahoochee river intake for Glades Reservoir for Alternatives 4 to 6 and the Baseline Conditions (L18). The Glades Alternatives with a yield of 30 mgd would result in maximum reduction in average daily flow of 5.9% to 7.1% on August 31st.

Figure 4.9 Average Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 4-6 and Baseline[1, 2,3]

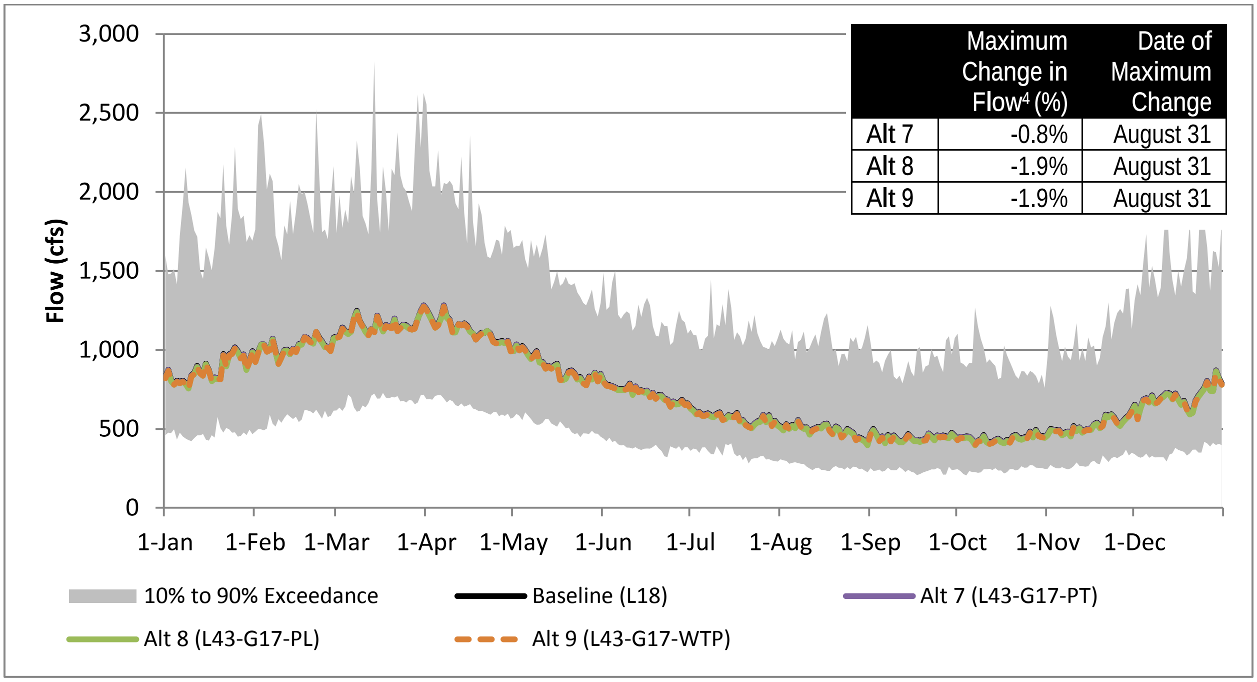


1 Period of analysis: January 1, 1939 through December 31, 2011.
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.
3 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.
4 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Draft Environmental Impact Statement

Figure 4.10 compares the average daily flow at the Chattahoochee river intake for Glades Reservoir for Alternatives 7 to 9 and the Baseline Conditions (L18). The Glades Alternatives with a yield of 17 mgd would result in maximum reduction in average daily flow of 0.8% to 1.9% on August 31st.

Figure 4.10 Average Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 7-9 and Baseline[1, 2,3]



1 Period of analysis: January 1, 1939 through December 31, 2011.

2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

3 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

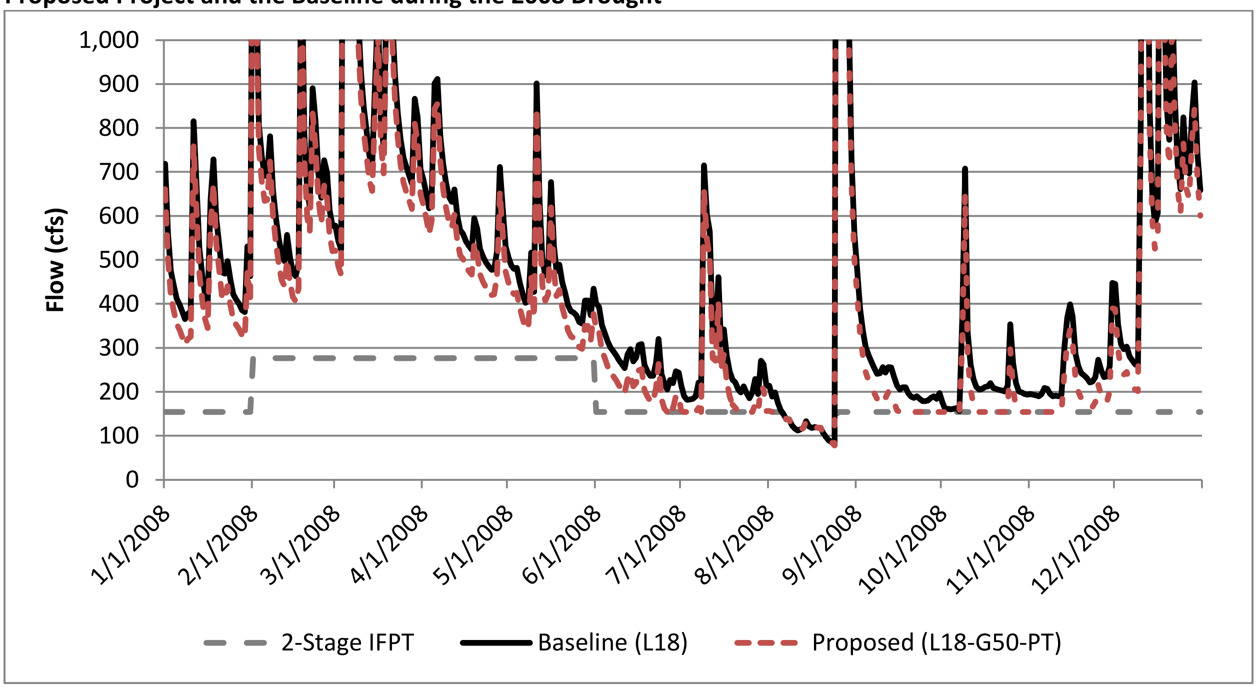
4 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

The impacts from the Proposed Project and its alternatives to the Chattahoochee River flow were also evaluated on daily basis during a critical drought period. **Figure 4.11** shows a comparison of the daily flow at the river intake for Glades Reservoir for the Proposed Project (L18-G50-PT) against the Baseline Conditions (L18) under 2008 drought conditions (*see the Selection of the 2008 Drought textbox*). The Proposed Project (L18-G50-PT) would result in a decrease in the daily river flow below the intake. The percent reduction is especially higher during period of low flows in summer and fall months when the Baseline river flow is just slightly higher than the IFPT. There is no flow reduction when the natural streamflow is below the IFPT during the summer and fall months of 2008, as no pumping is allowed. The percent flow reduction is lower during the spring months due to higher average flows during the spring.

Selection of 2008 Drought

Based on our evaluations of climate and hydrological data, and on the historical water surface elevation of Lake Lanier, the 2008 drought is the critical drought for the project area. Results are shown for additional drought periods in **Appendix Q**, along with average and wet year condition results. The justification for the selection of these representative years is also explained in **Appendix Q**.

Figure 4.11 (Close-up) Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of the Proposed Project and the Baseline during the 2008 Drought[1,2]

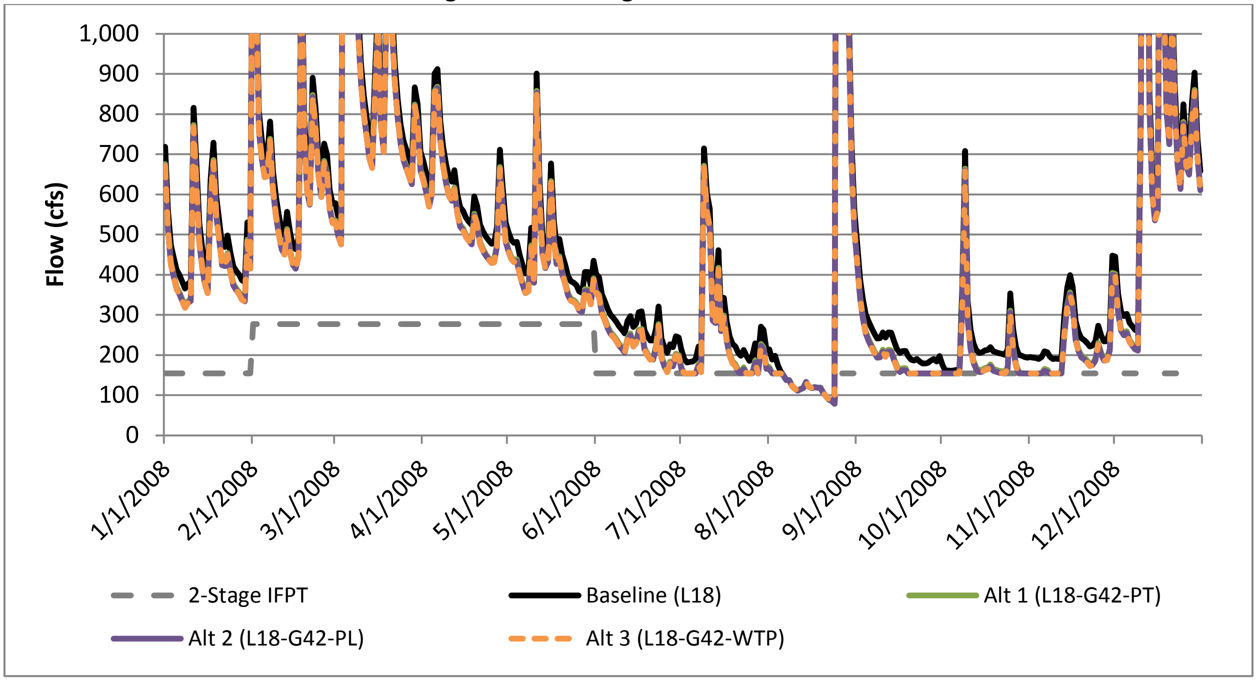


1 2-stage seasonal IFPT = 30% AADF (276 cfs) for the months of February through May and A7Q10 (154 cfs) for June through January, or the natural streamflow, whichever is less.

2 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

Figure 4.12 shows a comparison of the daily flow at the river intake for Glades Reservoir for Alternatives 1-3 and the Baseline Conditions (L18) under 2008 drought conditions. The Glades Alternatives with a yield of 42 mgd would result in a decrease in the daily river flow below the intake during 2008 when compared to the baseline flow. The flow differences amongst the transmission scenarios are negligible.

Figure 4.12 (Close-up) Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 1 to 3 to the Baseline during the 2008 Drought[1,2]

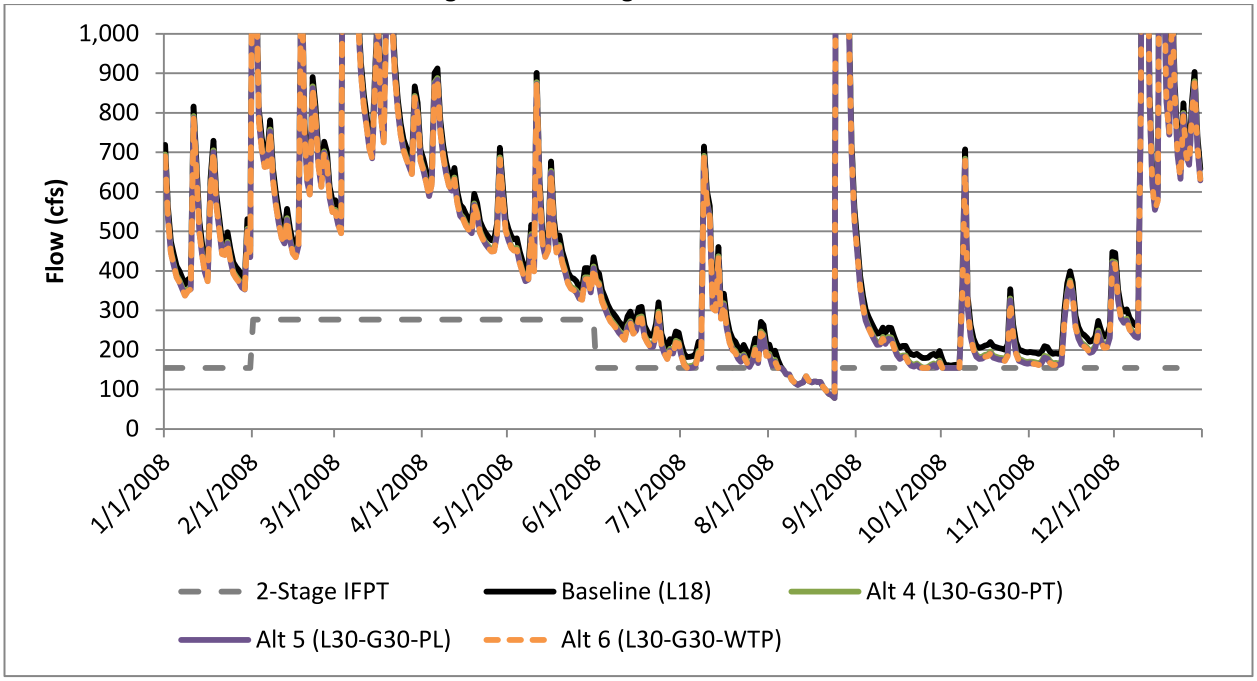


[1] 2-stage seasonal IFPT = 30% AADF (276 cfs) for the months of February through May and A7Q10 (154 cfs) for June through January, or the natural streamflow, whichever is less.

[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

Figure 4.13 shows a comparison of the daily flow at the river intake for Glades Reservoir for Alternatives 4-6 and the Baseline Conditions (L18) under 2008 drought conditions. The Glades Alternatives with a yield of 30 mgd would result in a decrease in the daily river flow below the intake during 2008 when compared to the baseline flow. The flow differences amongst the transmission scenarios are negligible.

Figure 4.13 (Close-up) Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 4 to 6 to the Baseline during the 2008 Drought[1,2]

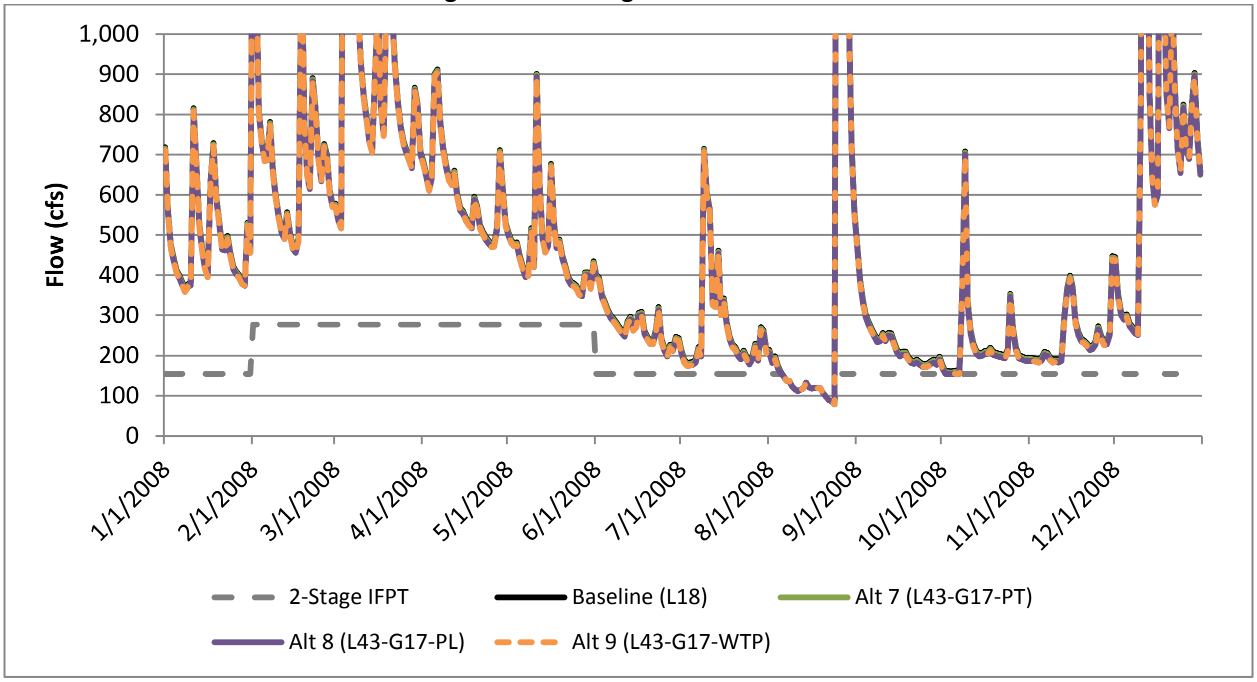


[1] 2-stage seasonal IFPT = 30% AADF (276 cfs) for the months of February through May and A7Q10 (154 cfs) for June through January, or the natural streamflow, whichever is less.

[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

Figure 4.14 shows a comparison of the daily flow at the river intake for Glades Reservoir for Alternatives 7-9 and the Baseline Conditions (L18) under 2008 drought conditions. The Glades Alternatives with a yield of 17 mgd would result in a slight decrease in the daily river flow below the intake during 2008 when compared to the baseline flow. The differences in flow reduction amongst the transmission scenarios are negligible. **Figures 4.11 to 4.14** show that the flow reduction during a critical drought period is less for reservoir alternatives with a lower safe yield.

Figure 4.14 (Close-up) Daily Flow at the Chattahoochee River Intake for Glades Reservoir: Comparison of Alternatives 7 to 9 to the Baseline during the 2008 Drought[1,2]



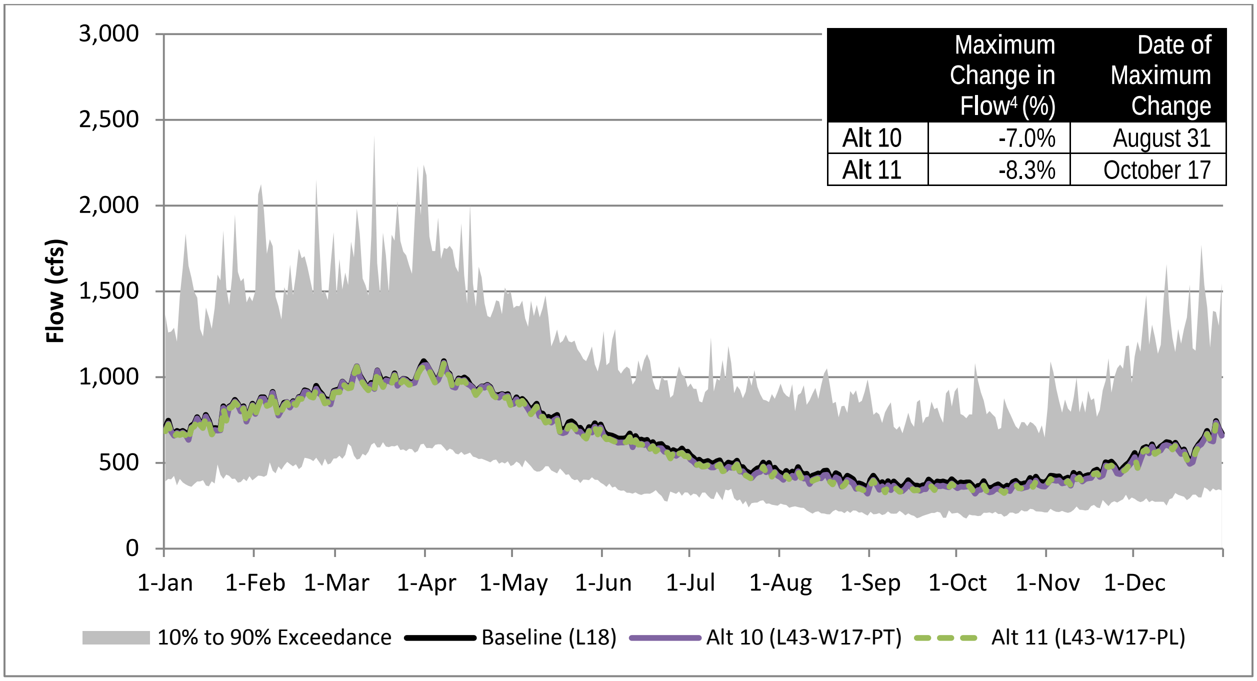
[1] 2-stage seasonal IFPT = 30% AADF (276 cfs) for the months of February through May and A7Q10 (154 cfs) for June through January, or the natural streamflow, whichever is less.

[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

White Creek Reservoir Alternatives

Figure 4.15 compares the average daily flow at the Chattahoochee river intake for White Creek Reservoir for Alternatives 10 to 11 and the Baseline Conditions (L18). The White Creek Alternatives with a yield of 17 mgd would result in an average daily flow reduction ranging from 7.0% to 8.3% from the Baseline, and would occur on August 31st and October 17th, respectively. The streamflow with Alternatives 10 to 11 in operation is predicted to be within the 10% to 90% exceedance range of flow without the reservoir (Baseline Conditions).

Figure 4.15 Average Daily Flow at the Chattahoochee River Intake for White Creek Reservoir: Comparison of Alternatives 10-11 and Baseline[1,2,3]



[1] Period of analysis: January 1, 1939 through December 31, 2011.

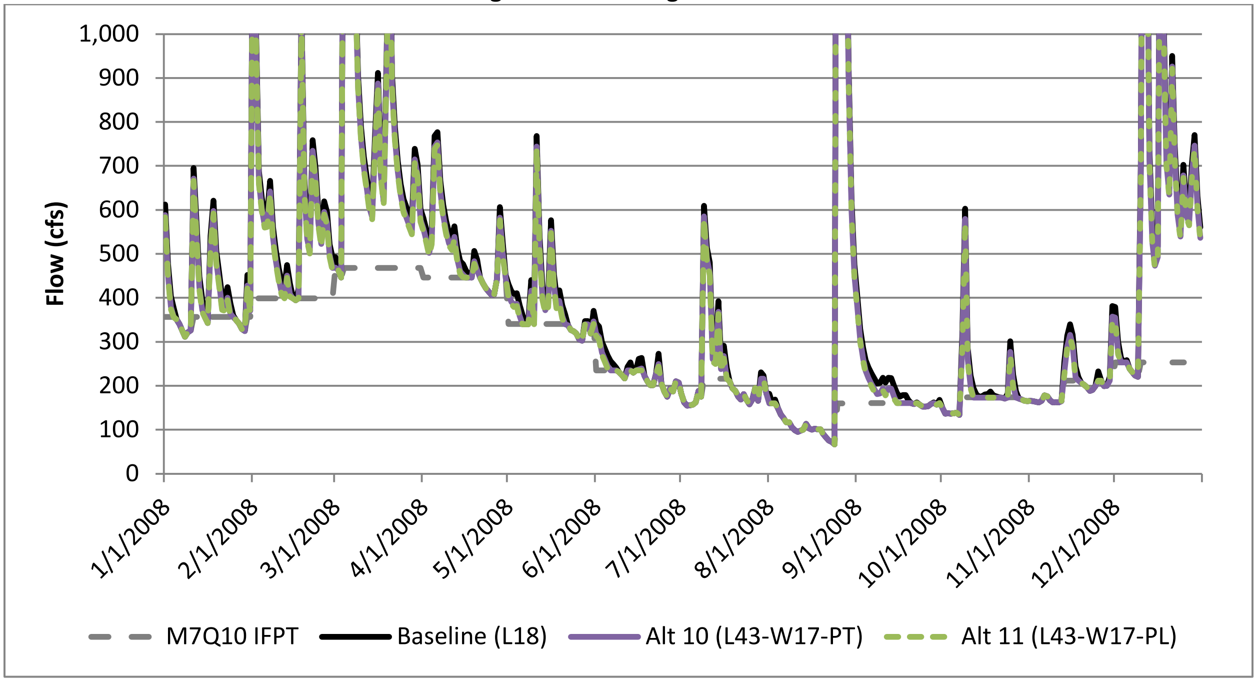
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

[3] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

[4] Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.16 shows a comparison of the daily flow at the river intake for White Creek Reservoir for Alternatives 10-11 and the Baseline Conditions (L18) under 2008 drought conditions. The White Creek Alternatives with a yield of 17 mgd would result in a slight decrease in the daily river flow below the intake during 2008 when compared to the baseline flow. The differences in flow reduction amongst the transmission scenarios are negligible.

Figure 4.16 (Close-up) Daily Flow at the Chattahoochee River Intake for White Creek Reservoir: Comparison of Alternatives 10 and 11 to the Baseline during the 2008 Drought[1,2]



1 M7Q10 IFPT = Variable monthly 7Q10, or the natural streamflow, whichever is less.

2 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.

4.3.3.2 Flow Alteration below Proposed Reservoirs

This section discusses the anticipated flow alteration in Flat Creek or White Creek below the proposed dam.

Table 4.8 shows the average daily flow and the range of daily flow in Flat Creek and White Creek with a reservoir (Proposed Project and Alternatives 1 to 11) and without the reservoirs (Baseline and No Action Alternatives). How water is conveyed from the reservoir to a WTP for treatment greatly impacts the average flow below the dam. PT alternatives increase the average flow below the dam while the PL and WTP alternatives decrease the average flows below the dam.

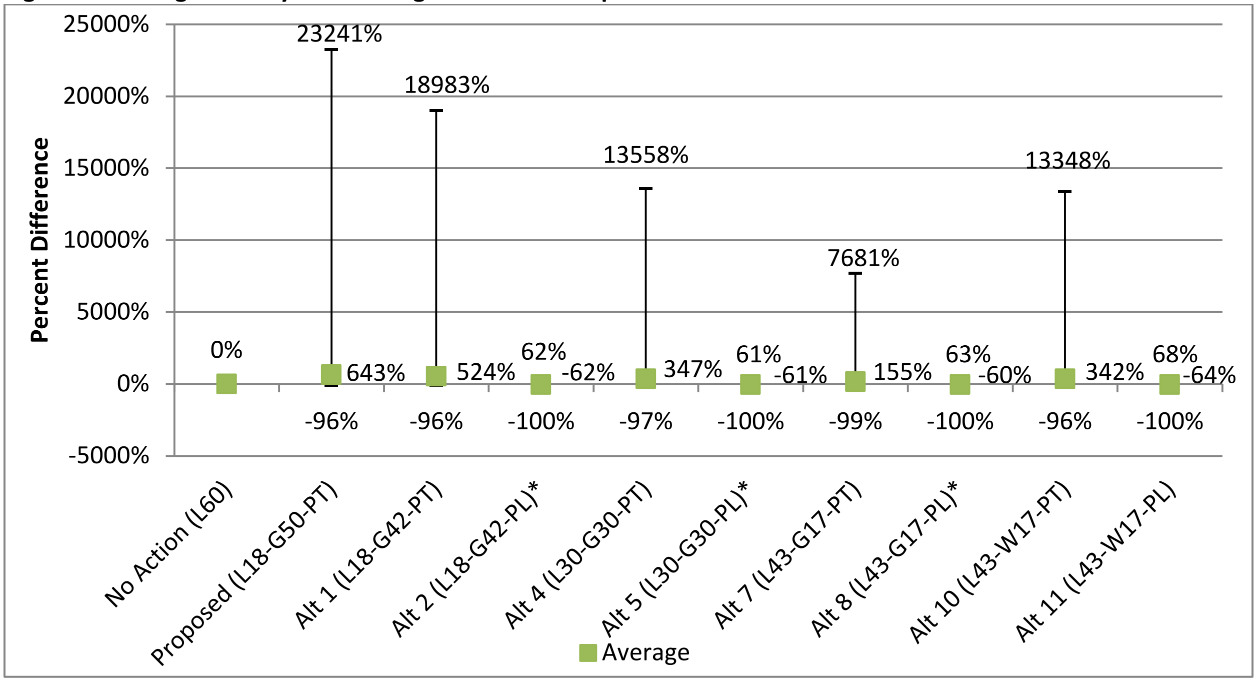
Table 4.8 Estimated Average, Minimum and Maximum Daily Flow (cfs) below the Proposed Dam With and Without a Project[1]

Alternative #	Alternative ID	Average Daily	Minimum Daily	Maximum Daily
Baseline- Flat Creek[2,3]	L18	27.1	0.4	1,719
Proposed	L18-G50-PT	79.0	68.1	1,543
1	L18-G42-PT	66.7	57.2	1,481
2	L18-G42-PL	6.3	0.4	1,424
3	L18-G42-WTP	6.3	0.4	1,424
4	L30-G30-PT	48.5	40.8	1,196
5	L30-G30-PL	6.6	0.4	1,180
6	L30-G30-WTP	6.6	0.4	1,180
7	L43-G17-PT	29.2	23.1	1,023
8	L43-G17-PL	7.2	0.4	1,025
9	L43-G17-WTP	7.2	0.4	1,025
Baseline- White Creek[2,4]	L18	15.8	0.2	998
10	L43-W17-PT	30.3	22.1	940
11	L43-W17-PL	6.8	0.2	951
No Action[5]	L60	NC[6]	NC[6]	NC[6]

1 Period of analysis: January 1, 1939 through December 31, 2011.
2 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02331600 Chattahoochee River near Cornelia, GA.
3 The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
4 The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare White Creek Alternatives (Alternatives 10-11).
5 The No Action Alternative evaluates the 2060 conditions without a project.
6 NC = No Change of flow statistics from Baseline at the respective intake location for the two reservoir sites.

The percent difference in flows in Flat Creek and White Creek with and without the reservoir is dependent on the transmission scenario of the alternative. **Figure 4.17** shows the range of the anticipated change of the daily flow compared to the Baseline Conditions (without a reservoir). Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size. The Proposed Project is estimated to decrease and increase the daily Flat Creek flow by -96% to +23,241%. On average, the Proposed Project increases the Flat Creek flow by +643%. The range of flow change for other Glades Reservoir alternatives decreases for alternatives with smaller safe yield targets. Alternative 1 is estimated to decrease and increase the daily Flat Creek flow by -96% to +18,983%. On average, Alternative 1 increases the Flat Creek flow by +524%. The range of Flat Creek flow change also decreases for PL and WTP transmission alternatives. The range of flow change for Alternatives 2 and 3 is -100% to +62%, with an average of -62%. Alternative 10 is estimated to increase the daily flow of White Creek by an average of 342%, while Alternative 11 is estimated to decrease the daily flow of White Creek by an average of 64%.

Figure 4.17 Range of Daily Flow Change below the Proposed Dam[1,2,3]



* Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size.

[1] Period of analysis: January 1, 1939 through December 31, 2012.

[2] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).

[3] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare White Creek Alternatives (Alternatives 10-11).

Table 4.9 summarizes the duration (in percent of time) and magnitude (percent change from baseline flow) that the daily flow is increased for the Proposed Project and its alternatives while **Table 4.10** summarizes the duration and magnitude that the daily flow is decreased for each alternative. The daily flow increases for all PT alternatives and decreases for all PL and WTP alternatives. The daily flow is occasionally decreased for PT alternatives, but the majority of the duration the flow increases. The Proposed Project increases the Flat Creek flow by 100% to 500% for 43% of the time.

When the water supply is withdrawn and pumped directly to a WTP (PL and WTP alternatives), the average flow decrease by more than -50% to -100% for the majority of the time (approximately 72% to 74% of time for Flat Creek and 77% of time for White Creek).

Table 4.9 Duration (in Percent of Time) and Magnitude (Percent Change from Baseline) of the Daily Flow Increases below the Proposed Dam[1]

Alternative #	Alternative ID	0% Change	0% to 5% Increase	5% to 10% Increase	10% to 20% Increase	20% to 50% Increase	50% to 100% Increase	100% to 500% Increase	500% to 1000% Increase	1000% to 5000% Increase	>5000% Increase
Baseline- Flat Creek[2]	L18	---	---	---	---	---	---	---	---	---	---
Proposed	L18-G50-PT	0.1%	1.3%	0.5%	0.9%	3.0%	6.4%	42.7%	23.4%	16.8%	0.8%
1	L18-G42-PT	0.1%	1.7%	0.7%	1.2%	4.2%	8.0%	45.2%	20.5%	12.4%	0.6%
2	L18-G42-PL	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	L18-G42-WTP	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	L30-G30-PT	0.2%	2.5%	1.5%	2.5%	6.7%	11.2%	45.0%	14.1%	6.4%	0.2%
5	L30-G30-PL	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	L30-G30-WTP	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	L43-G17-PT	0.3%	4.5%	2.6%	3.7%	9.7%	12.5%	34.4%	4.9%	1.9%	0.0%
8	L43-G17-PL	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	L43-G17-WTP	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Baseline- White Creek[3]	L18	---	---	---	---	---	---	---	---	---	---
10	L43-W17-PT	0.4%	6.5%	2.5%	2.7%	7.0%	11.3%	44.1%	13.9%	6.0%	0.2%
11	L43-W17-PL	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
No Action[4]	L60	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[1] Period of analysis: January 1, 1939 through December 31, 2012.
[2] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[3] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare White Creek Alternatives (Alternatives 10-11).
[4] The No Action Alternative evaluates the 2060 conditions without a project.

Table 4.10 Duration (in Percent of Time) and Magnitude (Percent Change from Baseline) of the Daily Flow Decreases below the Proposed Dam[1]

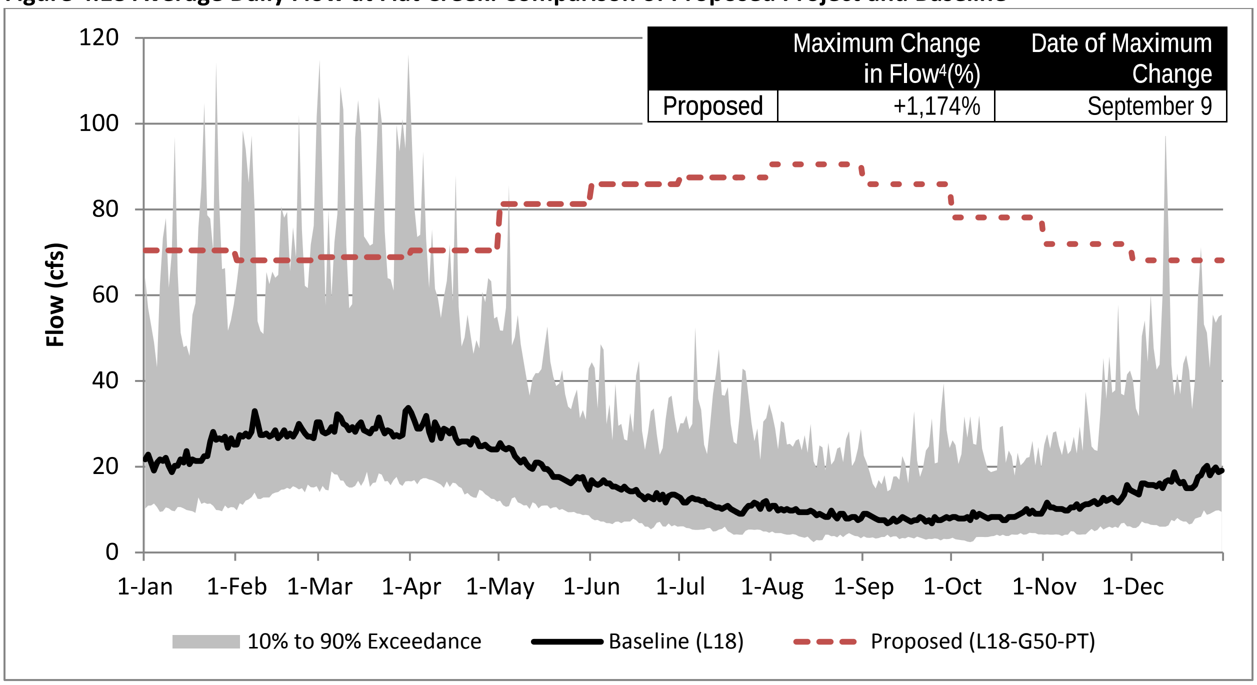
Alternative #	Alternative ID	0% to -5% Decrease	-5% to -10% Decrease	-10% to -20% Decrease	-20% to -50% Decrease	-50% to -100% Decrease	<-100% Decrease
Baseline- Flat Creek[2]	L18	---	---	---	---	---	---
Proposed	L18-G50-PT	0.7%	0.3%	0.4%	1.3%	1.3%	0.0%
1	L18-G42-PT	1.1%	0.4%	0.6%	1.7%	1.7%	0.0%
2	L18-G42-PL	1.5%	0.0%	2.7%	14.7%	73.9%	0.0%
3	L18-G42-WTP	1.5%	0.0%	2.7%	14.7%	73.9%	0.0%
4	L30-G30-PT	2.0%	0.7%	1.2%	3.0%	2.8%	0.0%
5	L30-G30-PL	1.5%	0.1%	2.7%	15.1%	73.4%	0.0%
6	L30-G30-WTP	1.5%	0.1%	2.7%	15.1%	73.4%	0.0%
7	L43-G17-PT	4.7%	2.5%	3.4%	7.9%	7.0%	0.0%
8	L43-G17-PL	1.6%	0.1%	3.0%	16.3%	71.8%	0.0%
9	L43-G17-WTP	1.6%	0.1%	3.0%	16.3%	71.8%	0.0%
Baseline- White Creek[3]	L18	---	---	---	---	---	---
10	L43-W17-PT	3.5%	0.4%	0.3%	0.6%	0.6%	0.0%
11	L43-W17-PL	0.8%	0.9%	2.7%	15.9%	76.6%	0.0%
No Action[4]	L60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[1] Period of analysis: January 1, 1939 through December 31, 2012.
[2] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[3] The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare White Creek Alternatives (Alternatives 10-11).
[4] The No Action Alternative evaluates the 2060 conditions without a project.

Glades Reservoir Alternatives

Figure 4.18 compares the estimated average daily flow below the Flat Creek Dam for the Proposed Project (L18-G50-PT) and the Baseline Conditions (L18). The Proposed Project would increase the average daily flow in Flat Creek. The largest deviation from the average daily baseline flow is +1,174% on September 9th. The magnitude of flow augmentation (from the water supply release) in Flat Creek is greater in summer and fall months because the baseline flows in Flat Creek are generally much lower during these months. The streamflow with the Proposed Project (L18-G50-PT) in operation is predicted to be greater than the natural range of baseline flow. The water supply releases (red dotted line) consider seasonal fluctuations of demand based on monthly to annual average demand factors calculated from Gainesville's WTP production data.

Figure 4.18 Average Daily Flow at Flat Creek: Comparison of Proposed Project and Baseline[1,2,3]

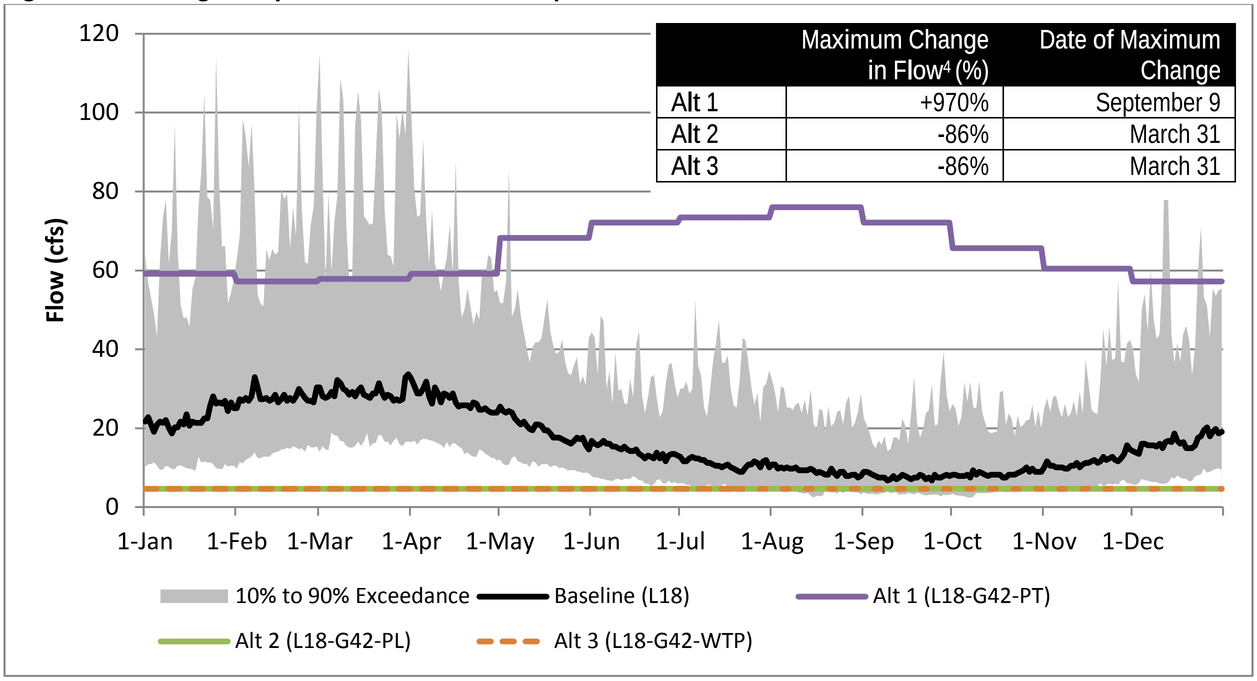


	Maximum Change in Flow[4](%)	Date of Maximum Change
Proposed	+1,174%	September 9

[1] Period of analysis: January 1, 1939 through December 31, 2011.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.
[3] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwannee, GA.
[4] Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.19 compares the average daily flows for different transmission scenarios when the Glades Reservoir safe yield (the water supply release or withdrawal) equals 42 mgd. For PT (Alternative 1), the water supply release from the reservoir into the Flat Creek results in a significant increase from the baseline flow conditions (up to +970%), while for PL and WTP (Alternatives 2 and 3) the flow in Flat Creek is reduced by -86% on March 31st to its IFPT levels when the water supply is withdrawn and pumped directly from the reservoir to a WTP.

Figure 4.19 Average Daily Flow at Flat Creek: Comparison of Alternatives 1 - 3 and Baseline[1,2,3]



	Maximum Change in Flow[4] (%)	Date of Maximum Change
Alt 1	+970%	September 9
Alt 2	-86%	March 31
Alt 3	-86%	March 31

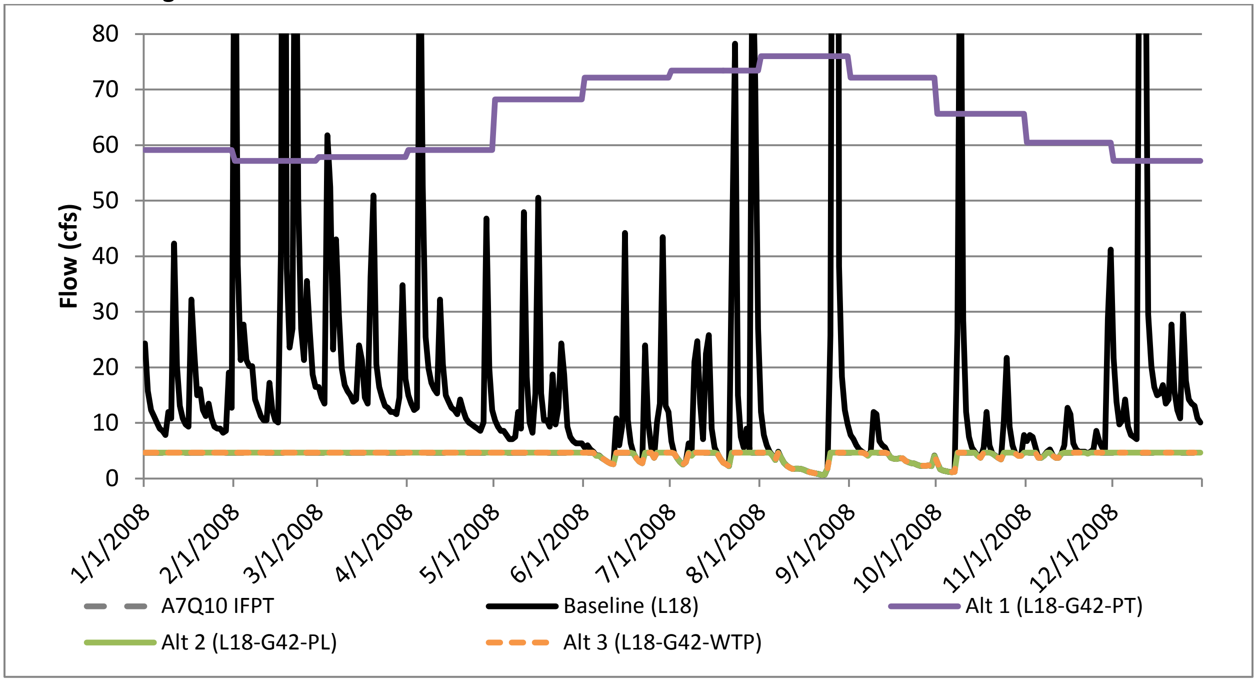
1 Period of analysis: January 1, 1939 through December 31, 2011.
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.
3 The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwannee, GA.
4 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

A close-up of the Flat Creek flow under 2008 drought conditions is shown in **Figure 4.20** for Alternatives 1 to 3. In a drought year, the flows in Flat Creek would be reduced to the IFPT (4.6 cfs, or the natural inflow, whichever is less) for Alternatives 2 and 3 most of the time. Alternative 1 would maintain a water supply release below the dam and significantly increase the streamflow in Flat Creek.

Results

As shown from the repetitive results presented for the Chattahoochee River intake for the Glades Reservoir Alternatives, the differences among each alternative group do not vary significantly. Based on this, representative groups of results are selected to discuss the types of impacts for the remainder of the surface water analysis. A complete display of the results for all alternatives can be found in **Appendix Q**.

Figure 4.20 (Close-up) Daily Flow below Glades Reservoir: Comparison of Alternatives 1-3 to the Baseline during the 2008 Drought[1,2]



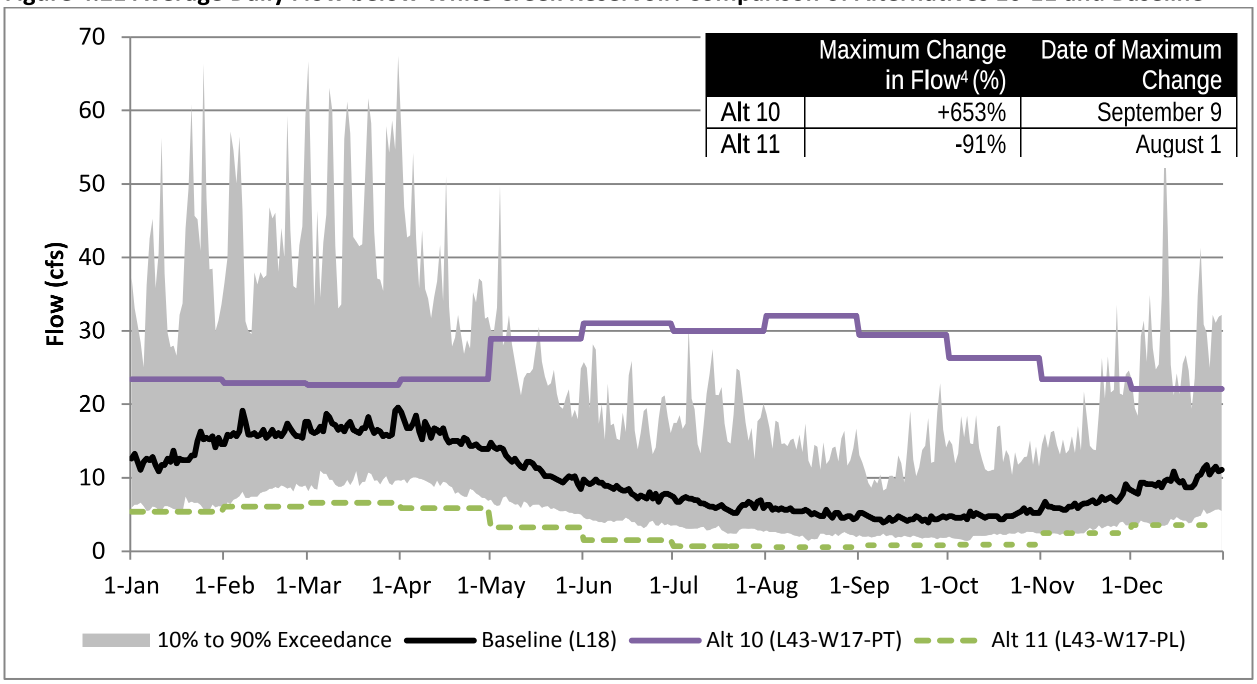
[1] A7Q10 IFPT = 4.6 cfs, or the natural streamflow, whichever is less.

[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwanee, GA.

White Creek Reservoir Alternatives

Figure 4.21 compares the estimated average daily flow below the White Creek Dam for Alternatives 10 and 11 and the Baseline Conditions (L18). The water supply release into the creek (Alternative 10) would result in average daily flow increase ranging from 16% to 653% below the dam. Alternative 11 (water supply pumped to Lakeside WTP directly) would result in average daily flow decrease ranging from 50% to 91%.

Figure 4.21 Average Daily Flow below White Creek Reservoir: Comparison of Alternatives 10-11 and Baseline[1,2,3]

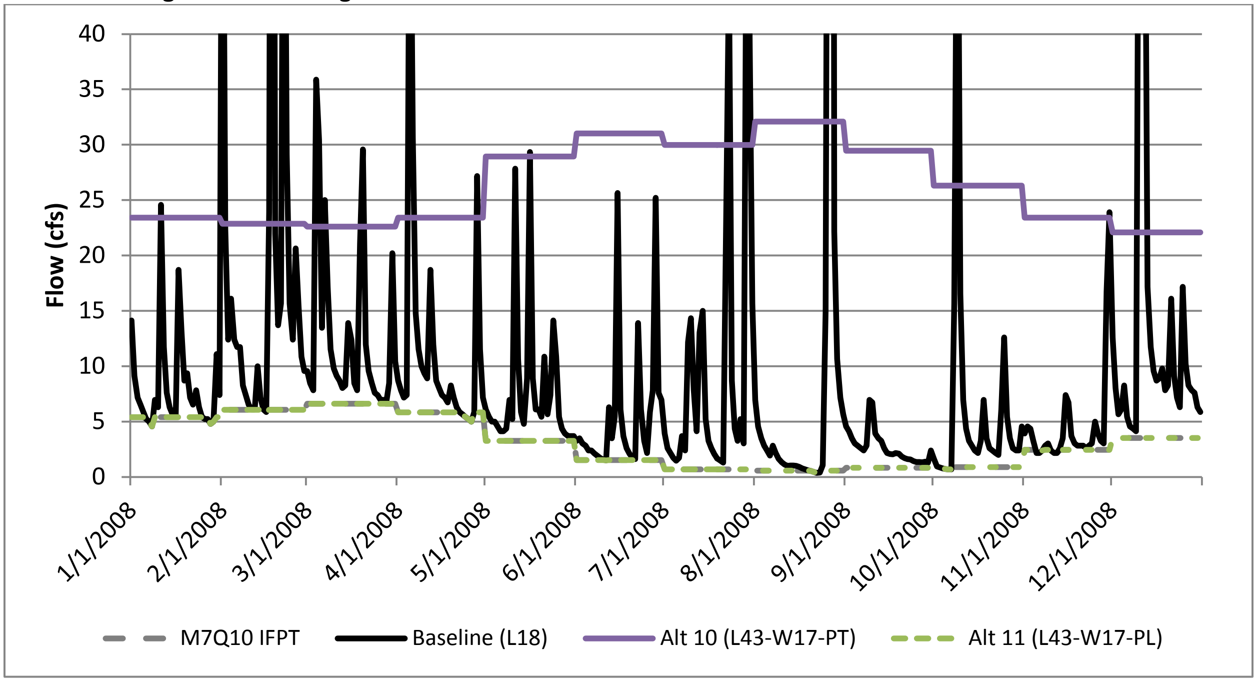


	Maximum Change in Flow[4] (%)	Date of Maximum Change
Alt 10	+653%	September 9
Alt 11	-91%	August 1

[1] Period of analysis: January 1, 1939 through December 31, 2011.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.
[3] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwannee, GA.
[4] Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

A close-up of the White Creek flow below the dam under 2008 drought conditions is shown in **Figure 4.22** for Alternatives 10 and 11. In a drought year, the flows in White Creek would be reduced to the IFPT for Alternative 11 most of the time. Alternative 10 would maintain a water supply release below the dam and significantly increase the streamflow in White Creek because of the flow passing through the creek to the river and Lake Lanier eventually.

Figure 4.22 (Close-up) Daily Flow below White Creek Reservoir: Comparison of Alternatives 10 -11 to the Baseline during the 2008 Drought[1,2]



[1] M7Q10 IFPT = M7Q10, or the natural streamflow, whichever is less.

[2] The flows at the proposed intake locations were calculated using a drainage area ratio conversion using USGS gage 02334885 Suwanee Creek at Suwanee, GA.

4.3.3.3 Flow Alteration into Lake Lanier

This section discusses the anticipated flow alteration in the Chattahoochee River as it flows into Lake Lanier.

Table 4.11 shows the average daily flow and the range of daily flow in the Chattahoochee River into Lake Lanier with a reservoir (Proposed Project and Alternatives 1 to 11) and without the reservoirs (Baseline and No Action Alternatives). How water is conveyed from the reservoir to a WTP for treatment greatly impacts the average flow below the dam. PT alternatives increase the average flow below the dam while the PL and WTP alternatives decrease the average flows below the dam.

Table 4.11 Estimated Average, Minimum and Maximum Daily Flow (cfs) into Lake Lanier With and Without a Project[1]

Alternative #	Alternative ID	Average Daily	Minimum Daily[7]	Maximum Daily
Baseline- Flat Creek[2,3]	L18	2,031	4.6	18,393
Proposed	L18-G50-PT	2,030	44.1	18,138
1	L18-G42-PT	2,030	45.6	17,994
2	L18-G42-PL	1,965	0.0	17,936
3	L18-G42-WTP	1,965	0.0	17,936
4	L30-G30-PT	2,030	44.6	17,997
5	L30-G30-PL	1,984	0.0	17,956
6	L30-G30-WTP	1,984	0.0	17,956
7	L43-G17-PT	2,030	34.0	18,000
8	L43-G17-PL	2,004	3.2	17,976
9	L43-G17-WTP	2,004	3.2	17,976
Baseline- White Creek[2,4]	L18	2,031	4.6	18,393
10	L43-W17-PT	2,030	27.1	18,395
11	L43-W17-PL	2,004	0.0	18,372
No Action[5]	L60	NC[6]	NC[6]	NC[6]

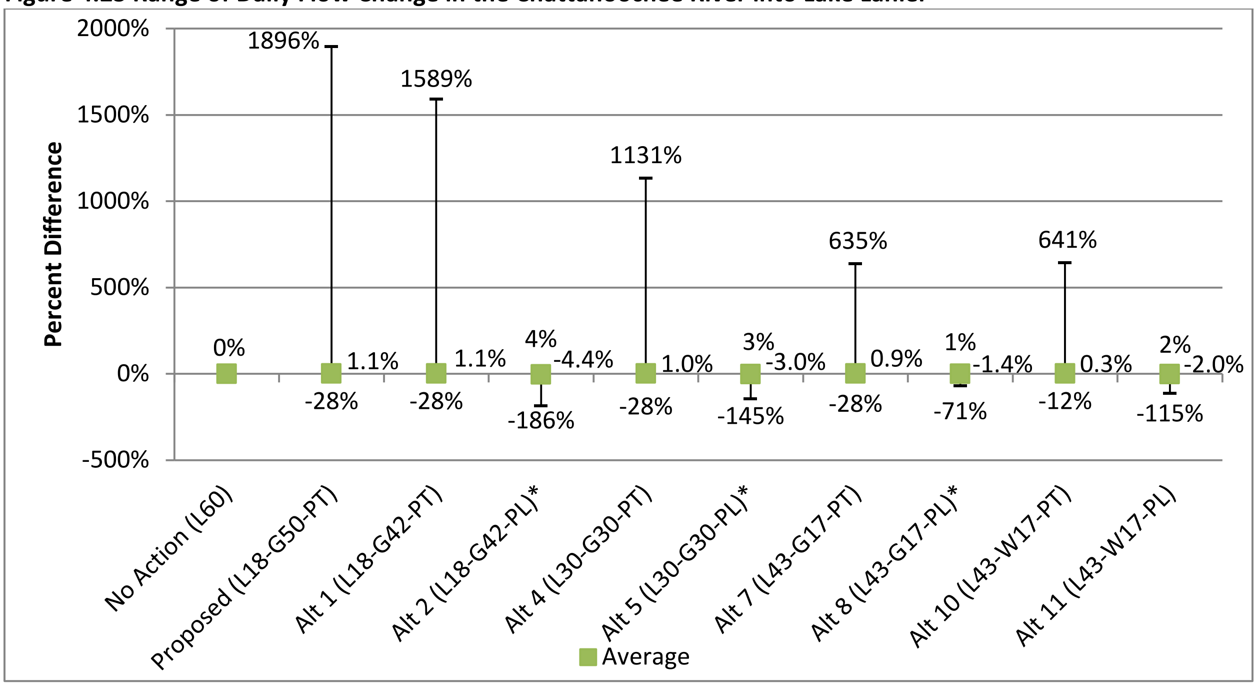
1 Period of analysis: January 1, 1939 through December 31, 2011.
2 The unimpaired flows into Lake Lanier were provided by the Corps.
3 The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
4 The Baseline Conditions evaluates the 2011 conditions without a project and is used to compare White Creek Alternatives (Alternatives 10-11).
5 The No Action Alternative evaluates the 2060 conditions without a project.
6 NC = No Change of flow statistics from Baseline at the respective intake location for the two reservoir sites.
7 Minimum daily flow was calculated after the flow was adjusted to match the unimpaired flows. More information can be found in **Appendix P**.

Figure 4.23 shows the range of the anticipated change of the daily flow compared to the Baseline Conditions (without a reservoir). Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size. On average, the Proposed Project increases the Chattahoochee River flow into Lake Lanier by +1.1%. The daily flow alteration for the Proposed Project at Flat Creek ranges from 28% decrease to 1,896% increase. The range of flow change for the other Glades Reservoir alternatives decreases for alternatives with smaller safe yield targets. The daily flow alternation for Alternative 1 is estimated to range from 28% decrease to 1,589% increase with an average increase of 1.1% for Alternative 1 at the Flat Creek.

The range of Chattahoochee River flow change also decreases for PL and WTP transmission alternatives. The range of flow change for Alternatives 2 and 3 is -186% to +4%, with an average of -4.4%.

Alternative 10 is estimated to increase the daily flow of the Chattahoochee River by an average of 0.3%, while Alternative 11 is estimated to decrease the daily flow of the Chattahoochee River into Lake Lanier by an average of -2%.

Figure 4.23 Range of Daily Flow Change in the Chattahoochee River into Lake Lanier[1,2,3]



* Results for the WTP transmission alternatives are not shown because they are identical to the PL transmission alternatives for the same reservoir yield size.

1 Period of analysis: January 1, 1939 through December 31, 2012.

2 The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).

3 The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).

Table 4.12 summarizes the duration (in percent of time) and magnitude (percent change from baseline flow) that the daily flow is increased for the Proposed Project and its alternatives while **Table 4.13** summarizes the duration and magnitude that the daily flow is decreased for each alternative. When water supply is released into the creek and pass-through Lake Lanier (PT alternatives), flow increase by a magnitude of less than 5% is estimated to occur approximately 46% to 58% of the time.

When water supply is pumped directly to a WTP (the PL and WTP alternatives), flow into Lake Lanier is expected to decrease. The decrease is less than 5% of the baseline flow for the majority of the period of time.

Table 4.12 Duration (in Percent of Time) and Magnitude (Percent Change from Baseline) of the Daily Flow Increases into Lake Lanier[1]

Alternative #	Alternative ID	0% Change	0% to 5% Increase	5% to 10% Increase	10% to 20% Increase	20% to 50% Increase	50% to 100% Increase	100% to 500% Increase	500% to 1000% Increase	□1000% Increase
Baseline- Flat Creek[2]	L18	---	---	---	---	---	---	---	---	---
Proposed	L18-G50-PT	16.8%	45.6%	2.5%	0.9%	0.4%	0.1%	0.1%	0.0%	0.0%
1	L18-G42-PT	15.9%	50.0%	2.6%	0.7%	0.3%	0.1%	0.1%	0.0%	0.0%
2	L18-G42-PL	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	L18-G42-WTP	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	L30-G30-PT	15.7%	54.5%	2.3%	0.6%	0.2%	0.1%	0.0%	0.0%	0.0%
5	L30-G30-PL	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	L30-G30-WTP	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	L43-G17-PT	15.0%	58.8%	2.0%	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%
8	L43-G17-PL	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	L43-G17-WTP	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Baseline- White Creek[3]	L18	---	---	---	---	---	---	---	---	---
10	L43-W17-PT	56.7%	18.8%	1.2%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%
11	L43-W17-PL	2.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
No Action[4]	L60	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[1] Period of analysis: January 1, 1939 through December 31, 2012.

[2] The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).

[3] The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).

[4] The No Action Alternative evaluates the 2060 conditions without a project.

Table 4.13 Duration (in Percent of Time) and Magnitude (Percent Change from Baseline) of the Daily Flow Decreases into Lake Lanier[1]

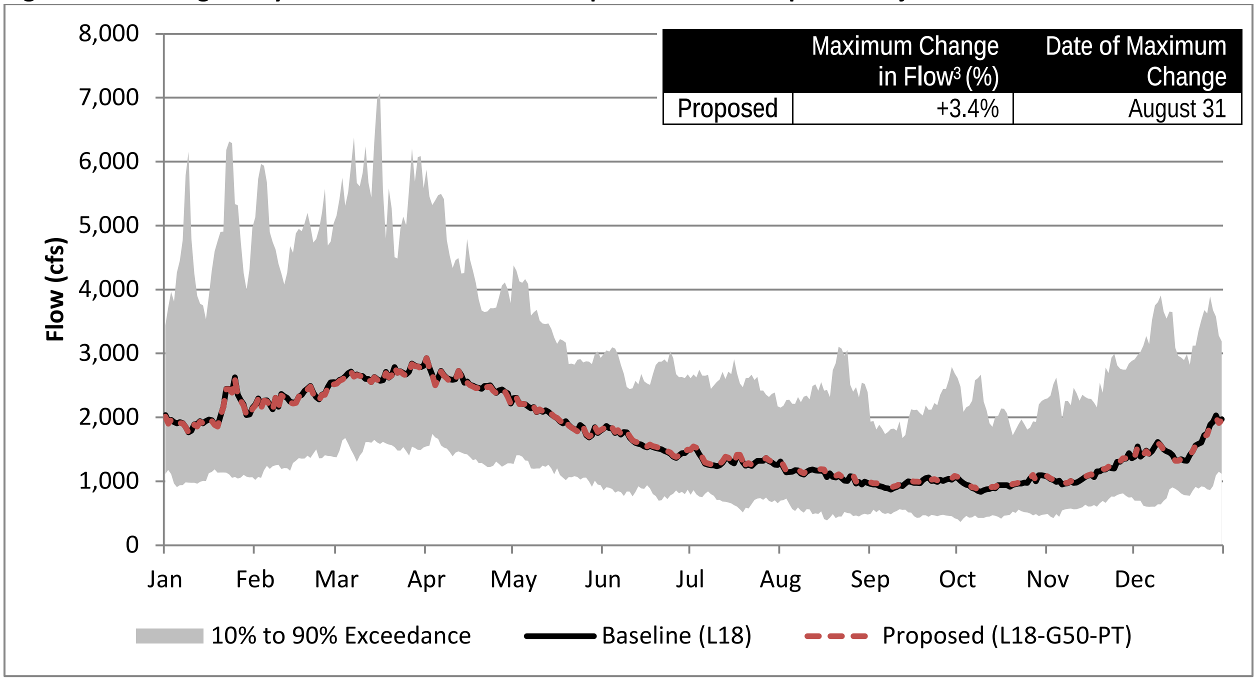
Alternative #	Alternative ID	0% to -5% Decrease	-5% to -10% Decrease	-10% to -20% Decrease	-20% to -50% Decrease	-50% to -100% Decrease	<-100% Decrease
Baseline- Flat Creek[2]	L18	---	---	---	---	---	---
Proposed	L18-G50-PT	33.0%	0.6%	0.1%	0.0%	0.0%	0.0%
1	L18-G42-PT	29.6%	0.6%	0.1%	0.0%	0.0%	0.0%
2	L18-G42-PL	70.7%	25.3%	3.1%	0.4%	0.0%	0.0%
3	L18-G42-WTP	70.7%	25.3%	3.1%	0.4%	0.0%	0.0%
4	L30-G30-PT	25.9%	0.6%	0.1%	0.0%	0.0%	0.0%
5	L30-G30-PL	91.2%	7.4%	0.8%	0.1%	0.0%	0.0%
6	L30-G30-WTP	91.2%	7.4%	0.8%	0.1%	0.0%	0.0%
7	L43-G17-PT	23.0%	0.6%	0.1%	0.0%	0.0%	0.0%
8	L43-G17-PL	98.3%	1.0%	0.1%	0.0%	0.0%	0.0%
9	L43-G17-WTP	98.3%	1.0%	0.1%	0.0%	0.0%	0.0%
Baseline- White Creek[3]	L18	---	---	---	---	---	---
10	L43-W17-PT	22.8%	0.1%	0.0%	0.0%	0.0%	0.0%
11	L43-W17-PL	93.0%	3.8%	0.3%	0.0%	0.0%	0.0%
No Action[4]	L60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[1] Period of analysis: January 1, 1939 through December 31, 2012.
[2] The Baseline Conditions evaluates the 2011 conditions without a project at the Glades Intake and is used to compare Glades Alternatives (Proposed and Alternatives 1-9).
[3] The Baseline Conditions evaluates the 2011 conditions without a project at the White Creek Intake and is used to compare White Creek Alternatives (Alternatives 10-11).
[4] The No Action Alternative evaluates the 2060 conditions without a project.

Glades Reservoir Alternatives

Figure 4.24 compares the estimated average daily flow into Lake Lanier between the Proposed Project (L18-G50-PT) and the Baseline Conditions (L18). The Proposed Project increases the average daily flow into Lake Lanier. The 4largest difference in the daily average flow is +3.4% on August 31st.

Figure 4.24 Average Daily Flow into Lake Lanier: Comparison of the Proposed Project and Baseline[1,2]



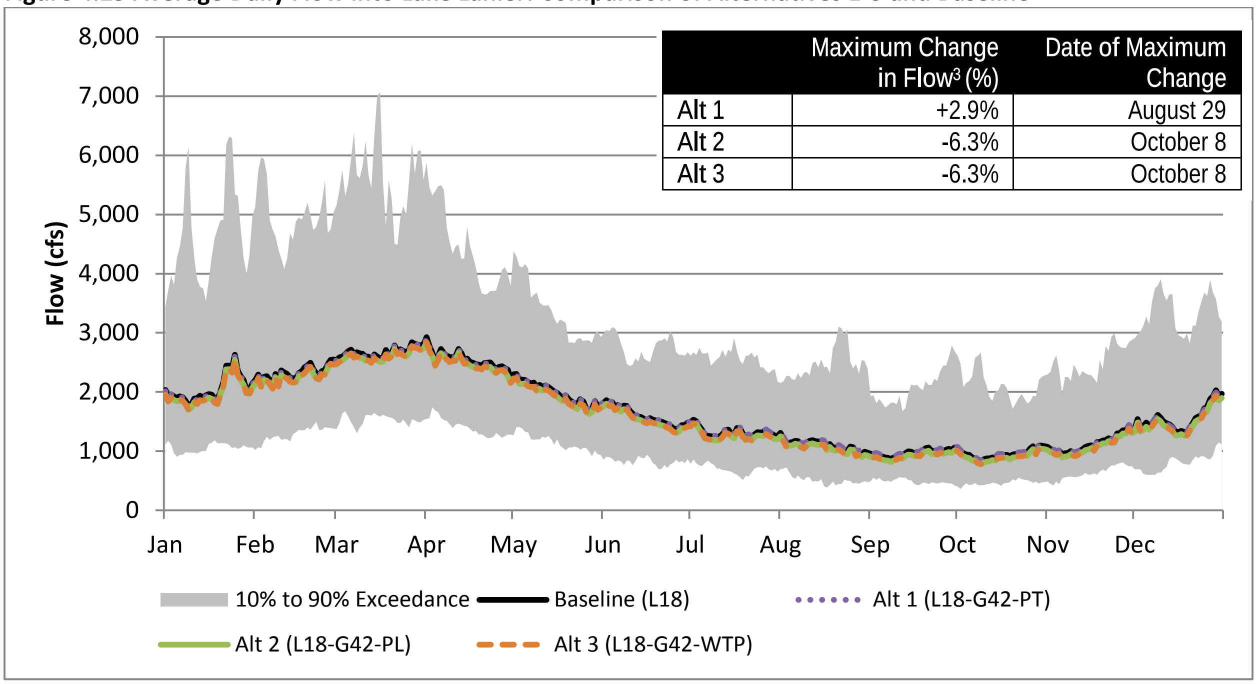
1 Period of analysis: January 1, 1939 through December 31, 2011.

2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

3 Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.25 compares the average daily flows into Lake Lanier for different transmission scenarios when the Glades Reservoir safe yield equals 42 mgd (Alternatives 1 to 3). When the water supply is released from the reservoir into Flat Creek to pass through Lake Lanier (Alternative 1), the flow is increased by up to 2.9%. The PL and WTP alternatives (Alternatives 2 and 3) decrease the average daily flow into Lake Lanier by up to 6.3%.

Figure 4.25 Average Daily Flow into Lake Lanier: Comparison of Alternatives 1-3 and Baseline[1,2]



[1] Period of analysis: January 1, 1939 through December 31, 2011.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.
[3] Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.26 shows a close-up of the Chattahoochee River flow into Lake Lanier under 2008 drought conditions for the Proposed Project (L18-G50-PT) and the Baseline Conditions (L18). In a drought year, the flows into Lake Lanier would be increased for the Proposed Project.

Figure 4.27 shows a close-up of the Chattahoochee River flow into Lake Lanier under 2008 drought conditions for Alternatives 1-3 and the Baseline Conditions (L18). In a drought year, Alternative 1 (PT transmission) would increase the flows into Lake Lanier, while Alternatives 2 and 3 (PL and WTP transmissions) would decrease the flows into Lake Lanier.

Figure 4.26 (Close-up) Daily Flow into Lake Lanier: Comparison of the Proposed Project to the Baseline during the 2008 Drought

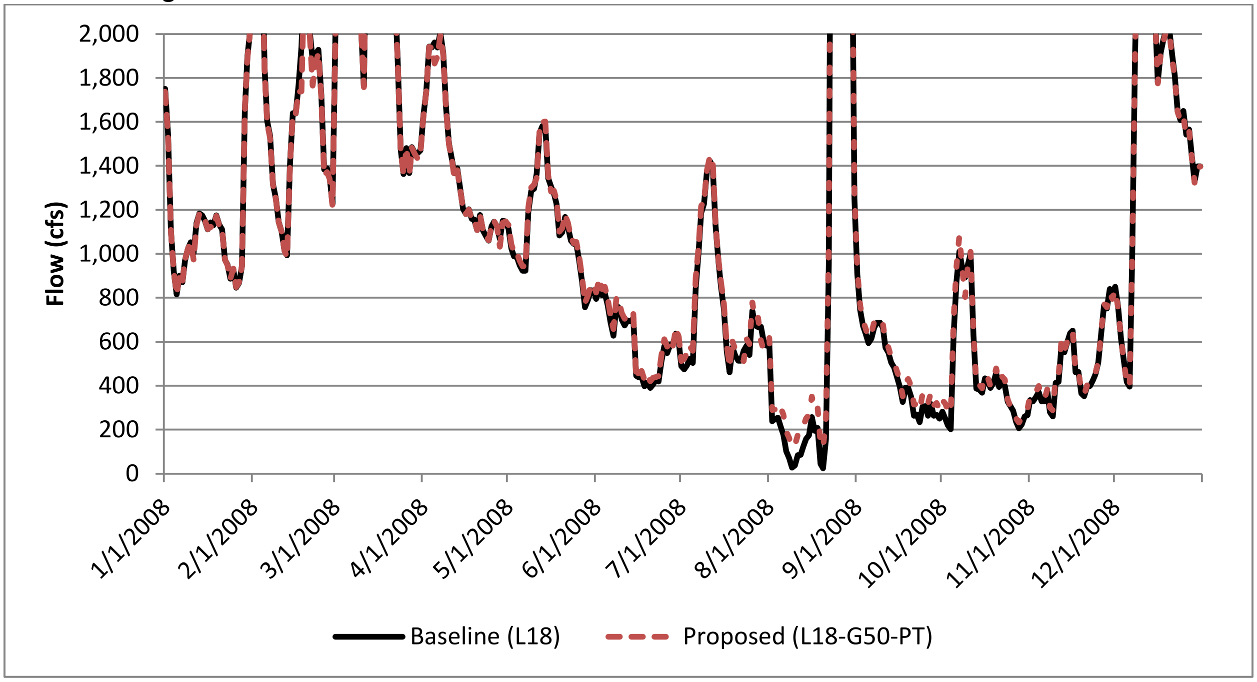
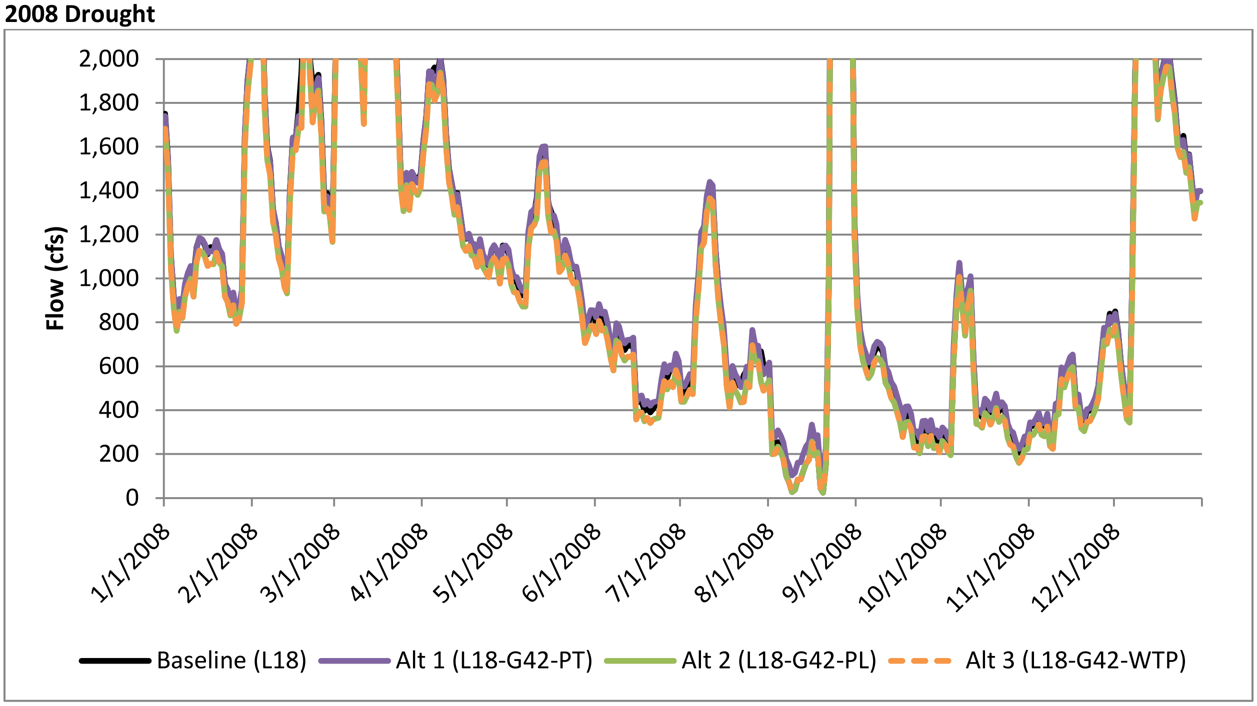


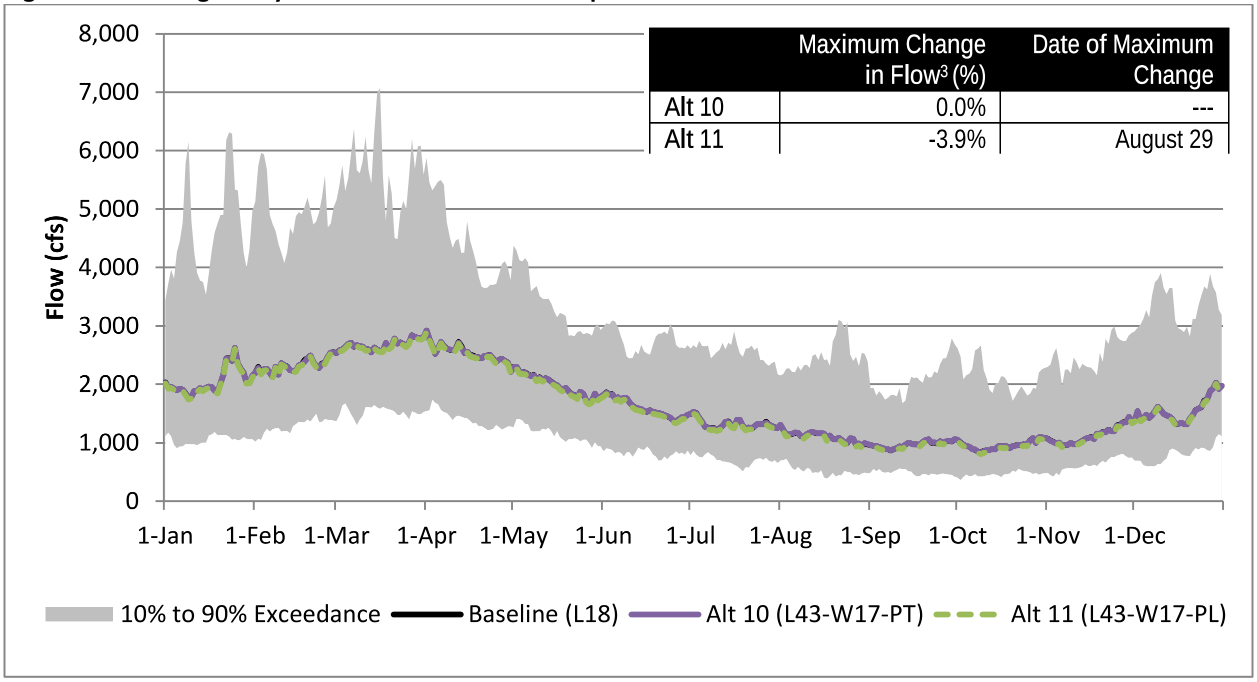
Figure 4.27 (Close-up) Daily Flow into Lake Lanier: Comparison of Alternatives 1-3 to the Baseline during the 2008 Drought



White Creek Reservoir Alternatives

Figure 4.28 compares the estimated average daily flow into Lake Lanier for the White Creek alternatives (Alternatives 10 and 11) and the Baseline Conditions (L18). Alternative 10 (PT transmission) would not change the daily flow into Lake Lanier. Alternative 11 (PL transmission) is estimated to decrease the average daily flow into Lake Lanier by up to 3.9% on August 29th.

Figure 4.28 Average Daily Flow into Lake Lanier: Comparison of Alternatives 10-11 and Baseline[1,2]



	Maximum Change in Flow[3] (%)	Date of Maximum Change
Alt 10	0.0%	---
Alt 11	-3.9%	August 29

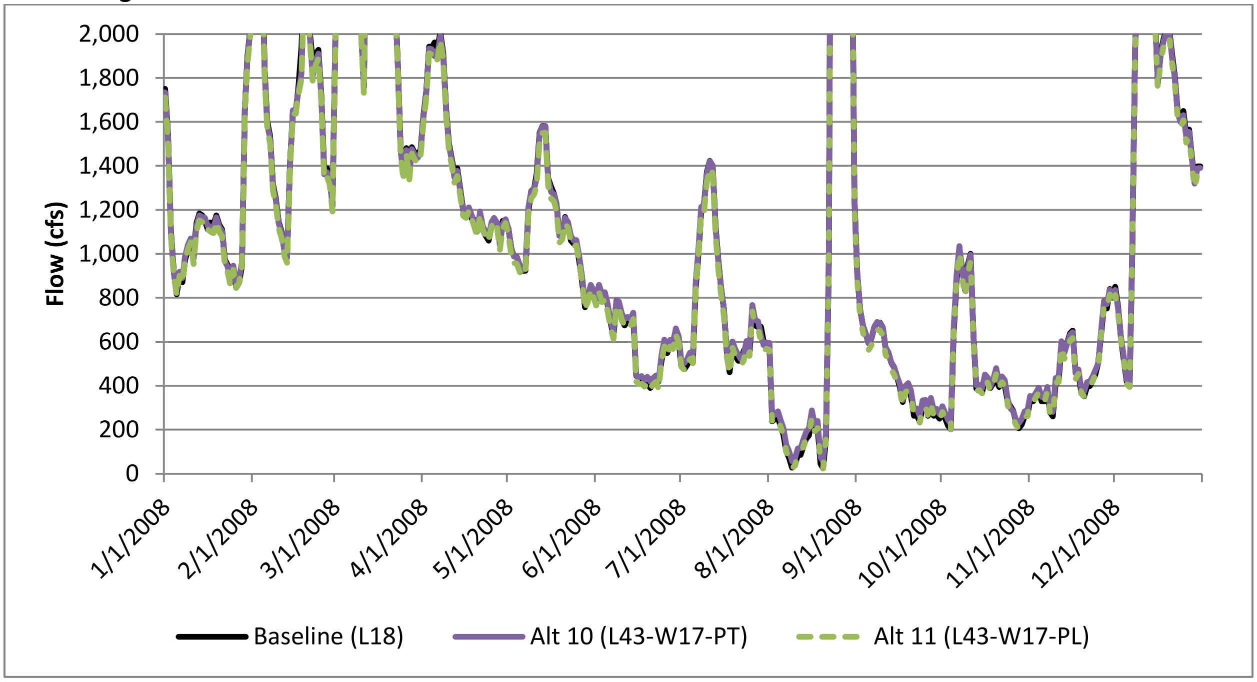
[1] Period of analysis: January 1, 1939 through December 31, 2011.

[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow at the intake exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow at the intake exceeds the shown value on the given day.

[3] Absolute maximum percent difference in average daily flow from Baseline to Action Alternative

Figure 4.29 shows a close-up of the Chattahoochee River flow into Lake Lanier under 2008 drought conditions for the Alternatives 10 and 11 and the Baseline Conditions (L18). In a drought year, neither Alternative 10 nor Alternative 11 is anticipated to increase or decrease the daily flow into Lake Lanier.

Figure 4.29 (Close-up) Daily Flow into Lake Lanier: Comparison of Alternatives 10-11 to the Baseline during the 2008 Drought



4.3.4 Indirect Impact Evaluation to the ACF Basin

This section discusses the downstream impacts to the entire ACF Basin from the Proposed Project and its alternatives. As described in the previous section, the direct impacts to the streamflow upstream of Lake Lanier were evaluated with a safe yield analysis model. The indirect downstream impacts from the alteration of the flow upstream of Lake Lanier to the ACF River Basin are evaluated with a hydrologic model as described in the next subsection. The methodology and the selection of the reservoir simulation model are described, and the simulated results from the model are used to discuss system-wide impacts. The downstream impacts are evaluated based on streamflow, reservoir elevation, reservoir discharge, hydropower operations, recreation, drought operations, and navigation.

Hydrologic Model Selection

ResSim is the tool most capable of dependably representing the Corps' reservoir operations (Corps, 2012). As of January 2010, the Corps Technical Excellence Network (TEN) guidance listed ResSim as "Community of Practice Preferred" for the purpose of reservoir system analysis.

The ResSim model was also used by the State of Georgia for their water supply request (2013).

4.3.4.1 Hydrologic Analysis

The Corps Hydrologic Engineering Center's (HEC) reservoir simulation model (ResSim) was used to generate hydrologic information for the analysis of the DEIS alternatives. HEC-ResSim (ResSim) was chosen as the hydrologic model for this analysis because the Corps already uses this model to simulate and test operations in the ACF Basin (*see the Hydrologic Model Section textbox*). ResSim performs simulations of reservoir operations for a series of Baseline Conditions and alternative operations, and allows comparison of the relative differences. The primary output of the ResSim model is continuously simulated daily lake levels and river flows throughout the ACF River Basin.

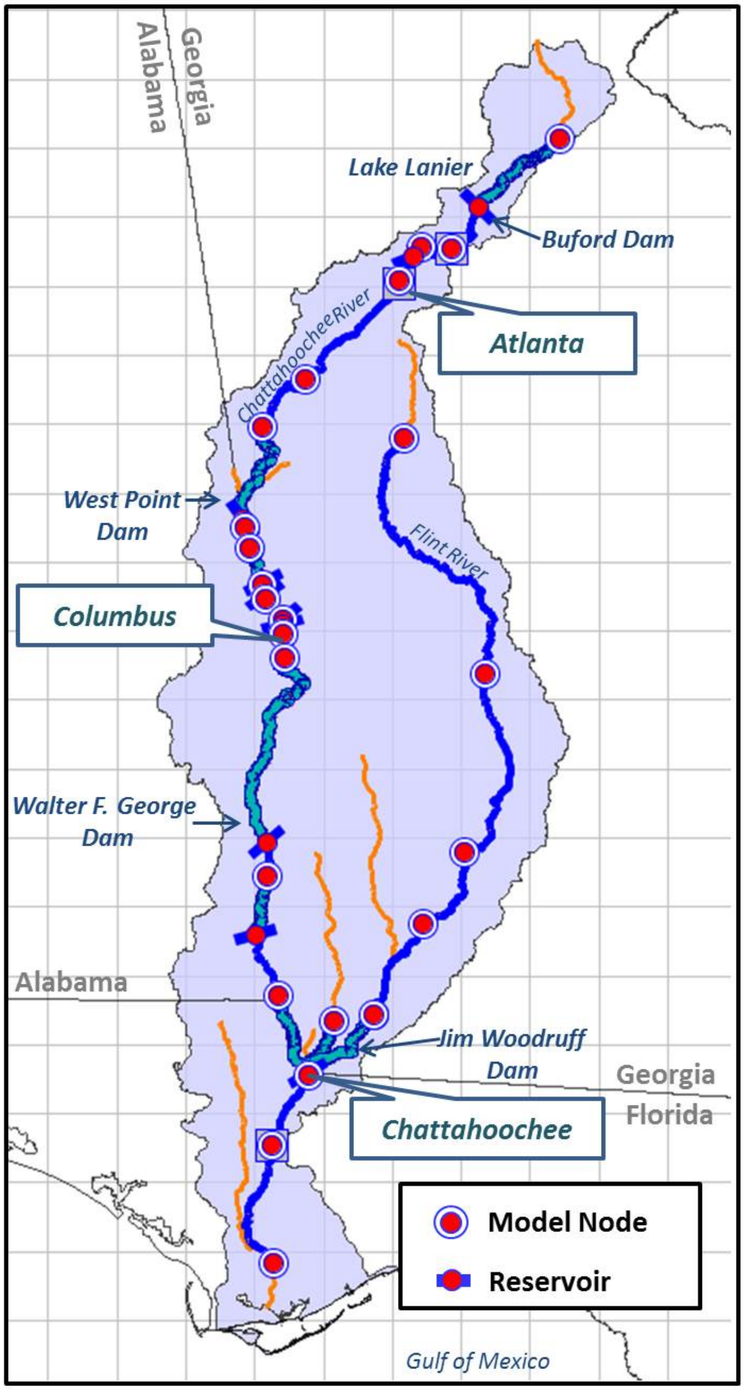
The ACF River Basin system is represented in the model as a system of virtual network elements, which correspond to actual physical features such as diversion structures, reservoirs, or stream gages. **Figure 4.30** shows the extent of the Corp's existing ACF Basin model from the headwaters of the Chattahoochee River above Lake Lanier to the Apalachicola River at Sumatra (downstream of Lake Seminole) along with the streamflow locations and reservoirs that were included in the ResSim model. The model includes operating variables associated with existing federally-owned reservoirs, as well as other privately owned reservoirs in the ACF River Basin.

The Corps' base model (*see Corps Baseline Model textbox*) was altered to include the Proposed Project and its alternatives. Each alternative is a combination of network, hydrologic input, and model conditions. The alternatives were added to the ResSim model by:

- Creating new networks that add the physical features of the alternatives to the existing baseline network,
- Adding the necessary hydrologic input data needed to run the ResSim model with the new alternative components, and
- Changing the water supply demands in order to simulate alternative conditions of the ACF Basin system.

The alternatives are used to evaluate incremental and cumulative impacts of future water supply projects. The Corps coordinated extensively throughout the development of the ResSim model and evaluation for this DEIS. Both the Corps Mobile District and the Corps Hydrologic Engineer Center have reviewed and verified the input, operations and results of the ResSim model for selective alternatives (**Appendix U**). **Appendix P** includes detailed information on the study period, network configuration, natural flow hydrology, physical attribute data, precipitation and evaporation rates, diversions and demands, and operational rights included in the ResSim model of the ACF River Basin.

Figure 4.30 Corps' Baseline ResSim Model of ACF River Basin (With Select Nodes and Dams labeled)



Corps Baseline Model

This DEIS analysis was conducted using the Corps' May 2012 ResSim base model of the ACF River Basin, "ACF_WCM-August2010_USFWS _Final." This version of the ACF River Basin model is also known as the "USACE May 2012 BiOp (Biological Opinion) Model."

This model was developed by the Corps Mobile District using ResSim Version 3.1 "Release Candidate 3, Build 42" for the period from January 1, 1939 to December 31, 2008. The label "Release Candidate" means that the software is undergoing final testing before distribution as an official version.

The original base model was updated to extend the study period for the DEIS analysis to 73 years, from calendar years 1939 through 2011.

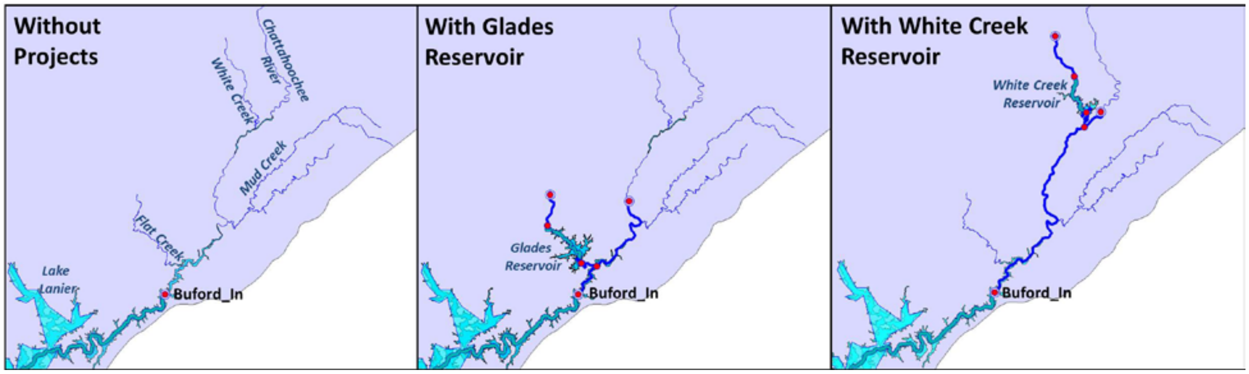
The Baseline Conditions was also updated from 2007 demands to 2011 demands.

Draft Environmental Impact Statement

Network

New networks, which are used to represent the physical features of the water supply system, were created in ResSim to represent the two alternative reservoir sites that were carried forward for detailed evaluation through the DEIS process, Glades Reservoir and White Creek Reservoir. **Figure 4.31** shows the addition of Glades and White Creek Reservoirs to the ResSim model. No transmission scenarios are shown, but each reservoir and transmission combination is a new network. Different alternatives can be evaluated for each network by changing the hydrologic input data or the model conditions.

Figure 4.31 The Existing Baseline Network (Without Projects) and the With Glades and White Creek Reservoir Networks as Modeled in ResSim



Model nodes represent a point in the basin where hydrologic data can be input, where water supply demands can be withdrawn, where minimum flow requirements must be met, or they can simply just be a location where model results are desired. New nodes were created upstream of Buford_In (where the Chattahoochee River flows into Lake Lanier) for the Glades and White Creek reservoir alternatives in order to simulate the flow at the Chattahoochee River intake and at Flat Creek and White Creek. Downstream of the Buford_In node, no changes were made to the Baseline (without project) network.

Glades and White Creek reservoirs were added to the networks and include operational rules for releases and storage volume. The operational rules for both White Creek and Glades Reservoir include Chattahoochee River pump station capacities, IFPT for the Chattahoochee River intake, and operational releases to meet IFPT requirements below the dam.

The addition of Glades and White Creek Reservoirs add additional storage to the ACF Basin system upstream of Buford Dam. **Table 4.14** summarizes the total usable conservation storage above Buford Dam for the various alternatives evaluated. The impacts of 2060 conditions (with and without reservoir) are evaluated based on a total of 297 mgd withdrawal under various total storage volume conditions above Buford Dam.

Table 4.14 Estimated Conservation Storage Volume above Buford Dam (BG)

Alternatives	Lake Lanier	Glades or White Creek Reservoir	Total Storage above Buford Dam
Baseline Conditions	341.9	0	341.9
No Action Alternative	341.9	0	341.9
Glades Reservoir Alternatives	341.9	9.4 (2.7% of total)	351.3
White Creek Reservoir Alternatives	341.9	3.4 (1.0% of total)	345.3

Notes: The volume shown above represents usable storage volume. Inactive or sediment storage is excluded above. BG = billion gallons.

Operations

The releases from the major Corps projects in the ACF River Basin system are currently managed under the Revised Interim Operating Plan (RIOP). The RIOP is the operational plan used to model all alternatives in the DEIS. Additional details about the RIOP can be found in Chapter 3.

Hydrologic Input Data

The ResSim model is simulated using daily hydrologic data that is manually input into the model at the model nodes and reservoirs as streamflows, evaporation, and precipitation. The 73-year period of analysis (1939-2011) includes a variety of hydrologic conditions such as dry, wet, and average years. The model uses a daily time step.

The historic streamflow data was provided by the Corps as unimpaired local flows. The unimpaired incremental local flows, evaporation, and diversion data were obtained from the Corps. Development of these data sets are described in unimpaired flow reports (*ACT/ACF Comprehensive Water Resource Study, Surface Water Availability Volume I: Unimpaired Flow*, July 1997 and *Extended Unimpaired Flow Report, January 1994 – December 2001 for ACT/ACF Basins*, April 2004) and updated in 2009 by the Corps Mobile District according to similar procedures as described in that document. Use of unimpaired inflows allows simulation to capture the natural variability of supplies to the system in terms of flow frequency and volume.

Net evaporation data for each reservoir project was provided by the Corps (Mobile District). Net evaporation is defined as the difference between the evaporation and precipitation for any period of time. When precipitation is greater than evaporation, net evaporation rates (as seen in wet months) are reported as negative values; when evaporation is greater than precipitation, positive net evaporation are reported (typical in dry months). The net evaporation data is multiplied by the estimated water surface area on a daily time step to determine the volume of evaporation lost or precipitation added to each reservoir each day. Due to the proximity of the Proposed Project and its alternatives to Lake Lanier, the same net evaporation rate was used to determine the net evaporation volume for both Lake Lanier and for Glades and White Creek alternatives.

Water Supply Demand Withdrawals

The model condition reflects the demand withdrawals and returns at each node in the model. Typically the model condition reflects the demands for a specific year or point in time. The following model conditions were evaluated in this DEIS:

- **Current Demands (2011)** - reflects the operation of the existing ACF River Basin system, and water demand withdrawals reflect recorded use from 2011.
- **Future Demands (2060)** - reflects the operation of the existing ACF River Basin system and water demand withdrawals projected for 2060.

The 2011 withdrawals and returns at each node in the model were provided by the Georgia EPD from their Georgia State Water Supply Request (2013). In 2011, the net withdrawal from Lake Lanier for uses in Hall County was approximately 17.7 mgd. In the model, the demand of Hall County (represented by City of Gainesville's permitted withdrawal) is combined with multiple municipalities and entities as part of a total withdrawal from Lake Lanier at the Buford_In node.

State of Georgia Water Supply Request

On May 16, 2000, Governor Roy Barnes of Georgia submitted a letter to the Assistant Secretary of the Army for Civil Works of the Corps requesting that the Corps manage the resources of Lake Lanier to allow total water withdrawals of 705 mgd from Lake Lanier and the Upper Chattahoochee River so that Georgia's projected 2030 water supply needs may be met.

On January 13, 2013, the State of Georgia submitted an updated water supply request to the Corps for a total withdrawal of 705 mgd from Lake Lanier and the Chattahoochee River for meeting Georgia's 2040 projected water supply demands in the Metro Atlanta area. The request includes withdrawals of 297 mgd from Lake Lanier and withdrawals of 408 mgd from the Chattahoochee River below Buford Dam and above the confluence of the Chattahoochee River and Peachtree Creek.

The Metro Atlanta area as modeled in ResSim includes the Buford, Norcross, Morgan Falls, and Atlanta nodes. **Table 4.15** provides a summary of water supply demands (withdrawals) and treated wastewater returns at each node in the model in the Metro Atlanta area for the 2011 demand conditions, and the withdrawals and returns as requested by the State of Georgia for 2040. The average return rate of treated wastewater for the entire Metro Atlanta area was approximately 70% based on actual withdrawal and return records for the year 2011 (provided by the Corps). The Georgia Water Supply Requests projected that the return rate will be 78% by 2040.

Table 4.15 Summary of Average Annual Water Supply Demands (Withdrawals) and Treated Wastewater Returns from GA Water Supply Request (2013)

	Nodes	2011	2040
Water Supply Withdrawals (mgd)	Buford	120.6	297.0
	Norcross	1.8	3.0
	Morgan Falls	111.4	183.6
	Atlanta	134.3	221.4
	Metro Atlanta Total	368.1	705.0
Treated Effluent Returns (mgd)	Buford	38.1	165.0
	Norcross	6.6	6.6
	Morgan Falls	27.9	87.4
	Atlanta	185.3	291.0
	Metro Atlanta Total	257.9	550.0
Metro Total (mgd)	Consumptive Use	110.2	155.0
	Return Rate (%)	70%	78%

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, and Atlanta nodes in the ResSim model

Future water withdrawals and wastewater discharges throughout Georgia's portion of the ACF River Basin were obtained from the Georgia EPD for year 2040 (consistent with Georgia's water supply request). The 2060 withdrawals and returns at the Metro Atlanta region nodes are kept equal to the 2040 Georgia Water Supply request. The 2060 withdrawals and returns for the remaining model nodes were interpolated from the 2040 projections provided by the Georgia EPD (see **Appendix P** for more details).

In the model, the demand of Hall County is combined with multiple municipalities and entities as part of a total withdrawal from Lake Lanier at the Buford_In node. **Table 4.16** lists the withdrawals for Hall County and the total withdrawal from Lake Lanier for each alternative. The total withdrawal from the Upper Chattahoochee River Basin would not exceed 297 mgd for Lake Lanier (or 705 mgd from the Metro Atlanta region) in any of the DEIS alternatives analyzed. **The water supply withdrawal from Glades Reservoir (or its alternative) is considered part of the 297 mgd request for the Lake Lanier withdrawal.** Based on this important condition, the total withdrawals for Hall County from Lake Lanier and from the reservoir component, whether it is Glades Reservoir or White Creek Reservoir, are always equal to 60 mgd for all alternatives, with the exception of the Applicant's Proposed Project (where the total withdrawal from Lake Lanier and Glades Reservoir for Hall County equals to 68 mgd). This exception is due to the Applicant's projected 2060 water demand being greater than the Corps' projections (see Chapter 2 and **Appendix D** for details).

Table 4.16 Summary of Withdrawals from Water Supply Alternative, Lake Lanier and Total Hall County Allocation (mgd, AAD)

		Hall County Withdrawal			
Alternative #	Alternative ID	Withdrawal from Lake Lanier	Withdrawal from Glades or White Ck Reservoir	Hall County Total Withdrawal	Total Lake Lanier Withdrawal
Baseline	L18	18	--	17.7	115.2
No Action	L60	60	--	60	297
Proposed	L18-G50-PT	18	50	68	297
1	L18-G42-PT	18	42	60	297
2	L18-G42-PL	18	42	60	297
3	L18-G42-WTP	18	42	60	297
4	L30-G30-PT	30	30	60	297
5	L30-G30-PL	30	30	60	297
6	L30-G30-WTP	30	30	60	297
7	L43-G17-PT	43	17	60	297
8	L43-G17-PL	43	17	60	297
9	L43-G17-WTP	43	17	60	297
10	L43-W17-PT	43	17	60	297
11	L43-W17-PL	43	17	60	297

Water supply withdrawal from Lake Lanier is a major component within each alternative; the quantity of future water supply allocation from Lake Lanier plays an important part in determining the timing and the need of other potential water supply components (such as construction of a new reservoir). The following describes the conditions and water supply demands for each alternative:

- **Baseline** - Hydrological modeling for the Baseline Conditions was based on current conditions (2011) annual withdrawal and discharge data of all the permitted municipal and industrial facilities in the ACF Basin.
- **No Action Alternative** - The No Action Alternative evaluates the 2060 water withdrawals and wastewater discharges without the presence of a water supply project. The total withdrawal for Hall County from Lake Lanier is projected to be 60 mgd.
- **Proposed Project** - The Proposed Project alternative evaluates the 2060 water withdrawals and wastewater discharges with the Glades water supply project providing 50 mgd. The total withdrawal for Hall County from Lake Lanier and from the Glades Reservoir component is 68 mgd for the Proposed Project; the Applicant's projected 2060 water demand is greater than the Corps' projections (Chapter 2).
- **Action Alternatives**- The total withdrawal for Hall County from Lake Lanier and from the reservoir component is always equal to 60 mgd for all action alternatives (Alternatives 1-11).

4.3.5 Downstream Impacts

This section discusses the anticipated hydrologic changes to the ACF Basin System as an indirect result of the Proposed Project and its alternatives, focusing on the impacts to streamflow, reservoir elevation, reservoir discharge, hydropower operations, recreation, drought operations, and navigation.

The action alternatives are compared to both Baseline (2011) and future conditions (2060). The comparison between the Baseline Conditions and the action alternatives identifies the impacts that are anticipated to occur as the entire ACF Basin demand grows and other projects/actions come on-line, regardless of Glades Reservoir or its alternatives. The comparison of action alternatives (with a reservoir) to No Action Alternatives (without a reservoir) in 2060 conditions isolates and identifies the effects that are specifically caused by the Proposed Project or its alternatives (construction of a new reservoir), as opposed to other projects/actions that are anticipated to occur between 2011 and 2060 and after a project would be built.

4.3.5.1 Impacts to Streamflow

Flows at select locations throughout the basin have been analyzed to determine the impact of the Proposed Project and its alternatives. **Table 4.17** summarizes the average daily flow at these select model node locations for each alternative. There is a reduction in flow at all of the selected model nodes from Baseline to 2060 conditions (including action and no-action alternatives). The action alternatives have very little discernible impacts to flow when compared to the No Action Alternative.

Table 4.17 Average Daily Simulated Flow (cfs) at Select Model Nodes from Upstream to Downstream[1]

Alternative #	Alternative ID	Atlanta	Whitesburg	Columbus	George Andrews	Chattahoochee	Blountstown
Baseline[2]	L18	2,195	3,742	6,455	10,137	21,031	21,580
No Action[3]	L60	1,962	3,713	6,342	10,062	20,890	21,438
Proposed	L18-G50-PT	1,962	3,712	6,341	10,062	20,889	21,437
1	L18-G42-PT	1,962	3,712	6,341	10,062	20,889	21,437
2	L18-G42-PL	1,962	3,712	6,341	10,062	20,889	21,437
3	L18-G42-WTP	1,962	3,712	6,341	10,062	20,889	21,437
4	L30-G30-PT	1,962	3,712	6,341	10,062	20,889	21,437
5	L30-G30-PL	1,962	3,712	6,341	10,062	20,889	21,437
6	L30-G30-WTP	1,962	3,712	6,341	10,062	20,889	21,437
7	L43-G17-PT	1,962	3,712	6,341	10,062	20,889	21,437
8	L43-G17-PL	1,962	3,712	6,341	10,062	20,889	21,437
9	L43-G17-WTP	1,962	3,712	6,341	10,062	20,889	21,437
10	L43-W17-PT	1,962	3,713	6,342	10,062	20,890	21,438
11	L43-W17-PL	1,962	3,713	6,342	10,062	20,890	21,438

[1] Period of Analysis: January 1, 1939 through December 31, 2011.
[2] The Baseline Alternative evaluates the 2011 conditions without a project.
[3] The No Action Alternative evaluates the 2060 conditions without a project.

Table 4.18 shows the percent reduction of average flow compared to the Baseline Conditions and No Action Alternative. The largest reduction in average flow (10.6%) from the Baseline Conditions is seen at the Atlanta node. The % reduction decreases to 0.7% further downstream in the system. The flow reduction from Baseline to all action alternatives and to the No Action Alternative is caused by the increase in system demand in the entire basin, rather than the addition of the reservoir (this would be discussed further in the Cumulative Effects section). There is no difference between the action alternatives and the No Action Alternative (L60) at all nodes.

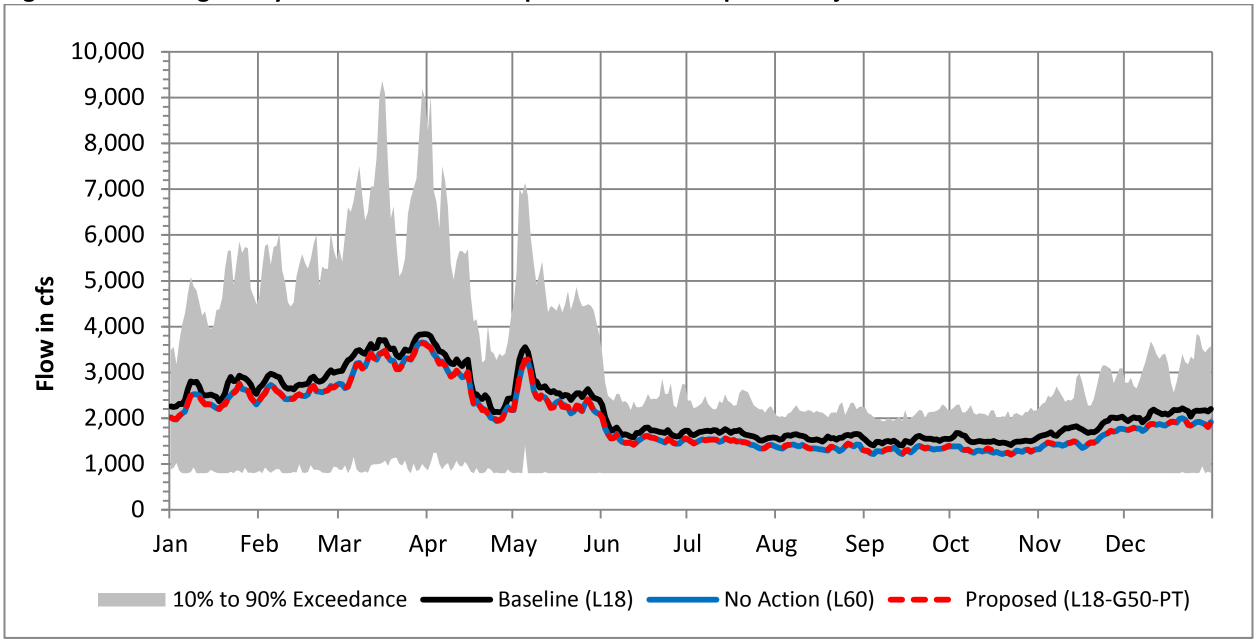
Table 4.18 Percent Change in Average Daily Simulated Flow from Baseline/No Action Alternative[1]

Alternative #	Alternative ID	Atlanta	Whitesburg	Columbus	George Andrews	Chattahoochee	Blountstown
Baseline	L18	---	---	---	---	---	---
No Action	L60	-10.6%	-0.8%	-1.7%	-0.7%	-0.7%	-0.7%
Proposed	L18-G50-PT	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
1	L18-G42-PT	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
2	L18-G42-PL	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
3	L18-G42-WTP	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
4	L30-G30-PT	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
5	L30-G30-PL	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
6	L30-G30-WTP	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
7	L43-G17-PT	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
8	L43-G17-PL	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
9	L43-G17-WTP	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
10	L43-W17-PT	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%
11	L43-W17-PL	-10.6% /0.0%	-0.8% /0.0%	-1.8% /0.0%	-0.7% /0.0%	-0.7% /0.0%	-0.7% /0.0%

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

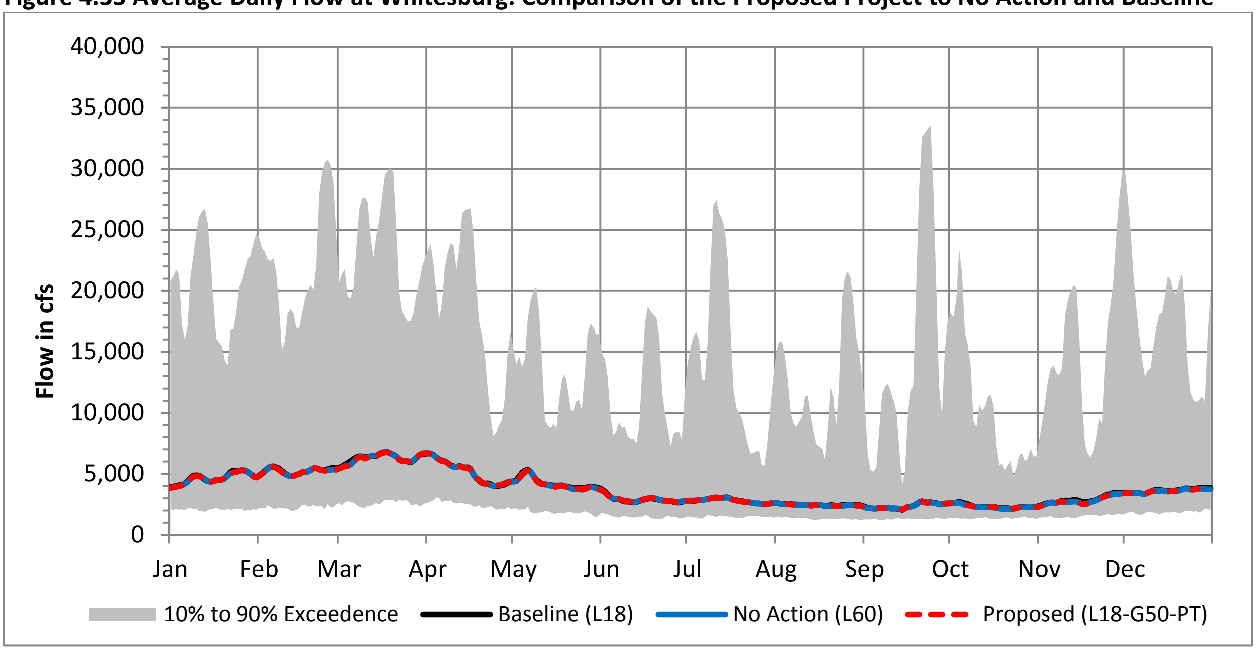
Figure 4.32 through **Figure 4.37** compares the average daily flow at the selected nodes between the Baseline, No Action Alternative (without a reservoir), and the Proposed Project (L18-G50-PT) at multiple nodes. At the Atlanta node, there is a reduction to the average daily flow with the Proposed Project from the Baseline Conditions, and there is no discernible change in average daily flow with the Proposed Project from the No Action Alternative. Downstream of the Atlanta node, there is no discernible change in streamflow.

Figure 4.32 Average Daily Flow at Atlanta: Comparison of the Proposed Project to No Action and Baseline[1,2]



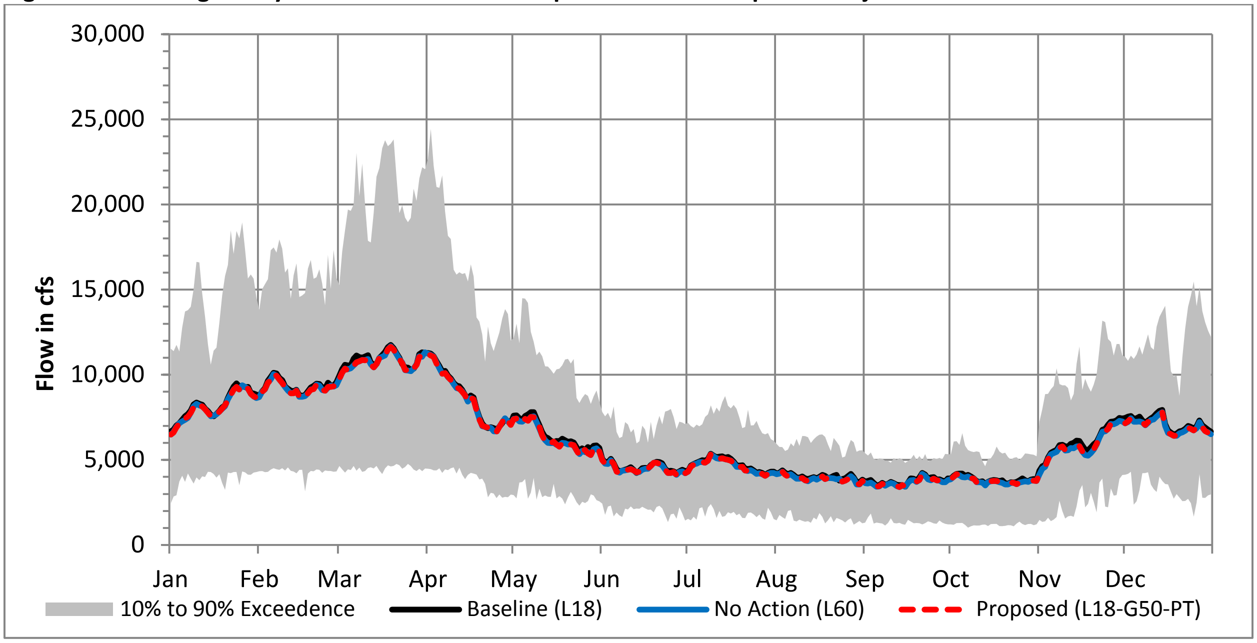
[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.33 Average Daily Flow at Whitesburg: Comparison of the Proposed Project to No Action and Baseline[1,2]



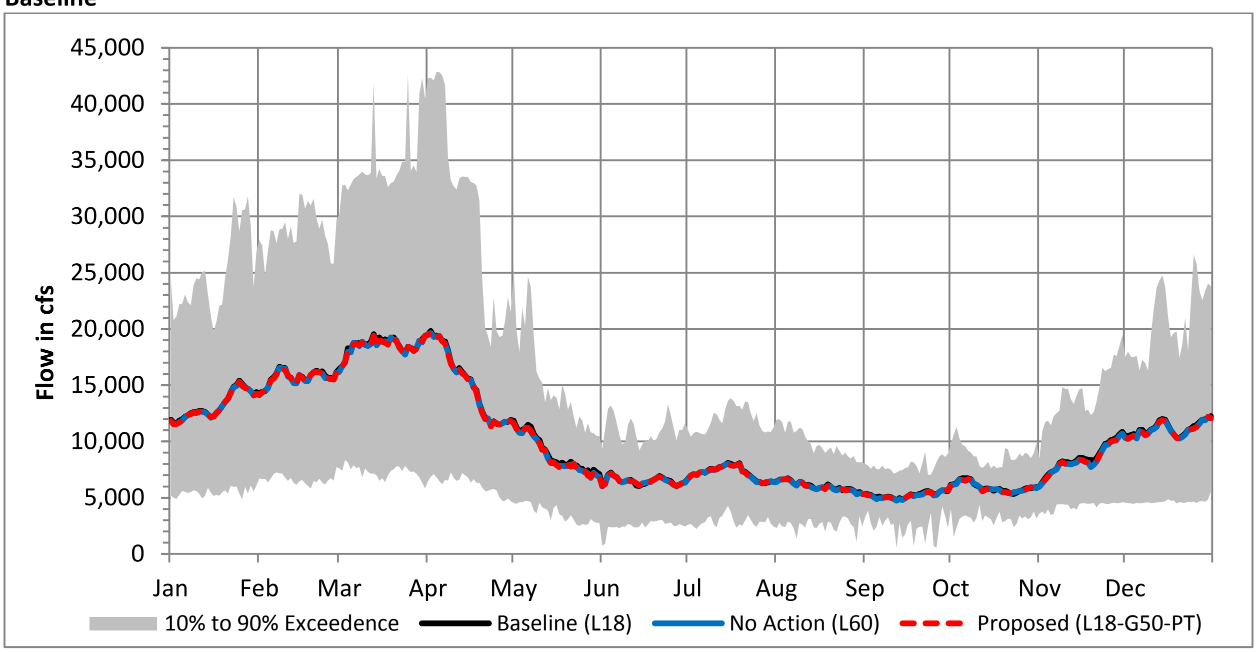
[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.34 Average Daily Flow at Columbus: Comparison of the Proposed Project to No Action and Baseline[1,2]



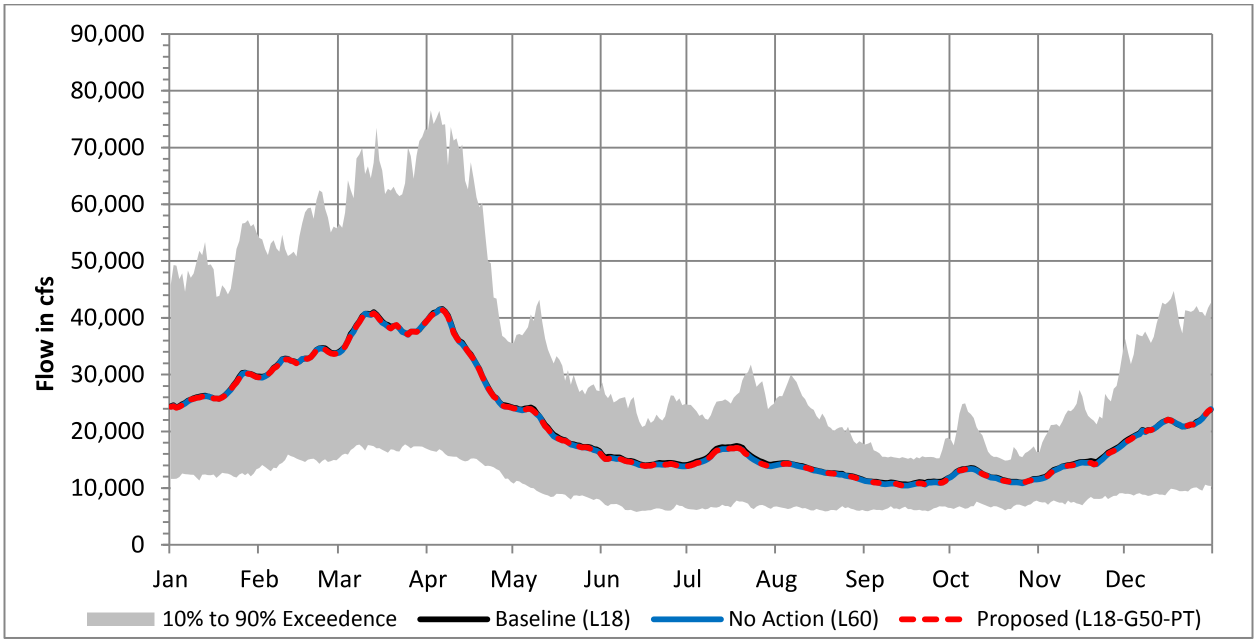
[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.35 Average Daily Flow at George Andrews: Comparison of the Proposed Project to No Action and Baseline[1,2]



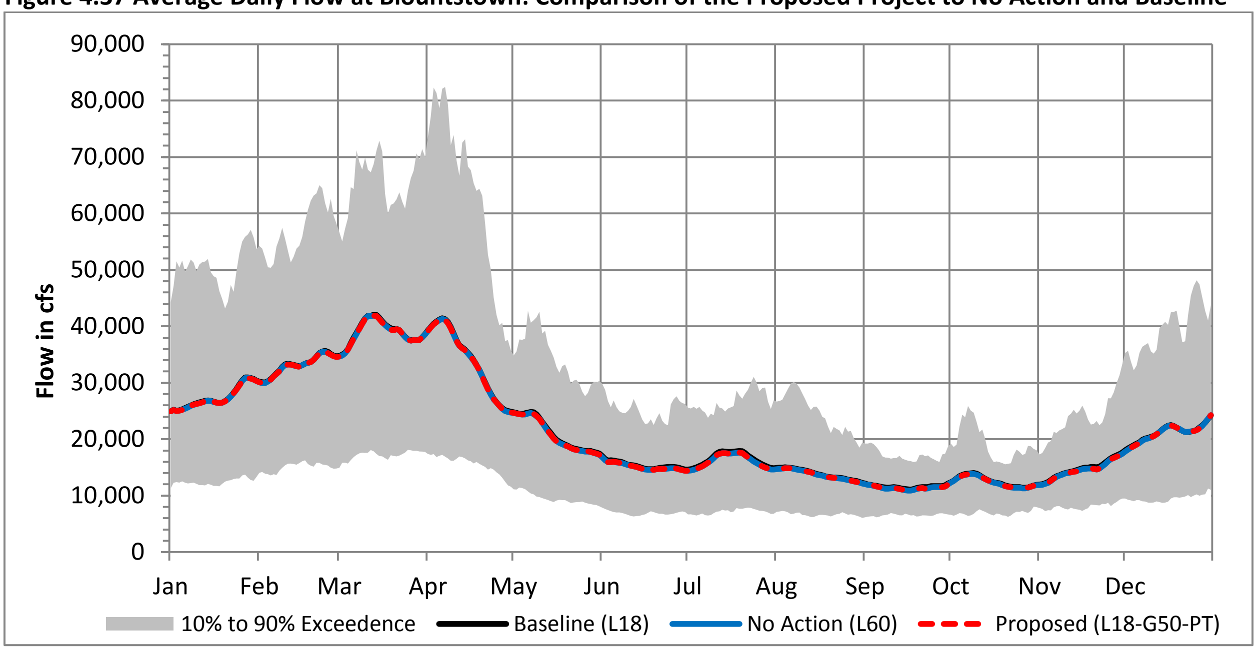
[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.36 Average Daily Flow at Chattahoochee: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.37 Average Daily Flow at Blountstown: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2012.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

4.3.5.2 Impacts to Pool Elevation

The Corps operates a series of reservoirs in the ACF River Basin together, as a system, to provide for a number of authorized project purposes. Each of the authorized project purposes is considered when making operational decisions, and these decisions affect how water is stored and released from the projects. The multiple water demands in the basin require that the Corps operates the system in a balanced manner in an attempt to meet all authorized purposes, while continuously monitoring the total system water availability to ensure that project purposes can be minimally satisfied during critical drought periods.

Action zones have been defined for each of the major storage projects (Buford, West Point, and Walter F. George). These zones are used to determine the amount of storage available for purposes such as flood damage reduction, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply. Zone 1, the highest in each lake, defines a reservoir condition where all authorized project purposes can be achieved. As lake levels decline, Zones 2 through 4 define increasingly critical system water shortages and guide the Corps in reducing flow releases as it becomes increasingly difficult to satisfy all purposes. Flow releases are reduced as pool levels drop because of drier-than-normal or drought conditions.

Composite storage is the sum of the total storage available each day for Buford, West Point Lake, and Walter F. George. The composite storage is used together with basin inflow and seasons to set up minimum release provisions at Jim Woodruff, and to balance the use of system conservation storage based on individual project storage amounts and the ability to refill the reservoirs.

Table 4.19 shows the average pool elevation for all of the Corps projects for each alternative. On average, the addition of reservoir storage is shown to increase the daily pool elevation of Lake Lanier. There is a 1-foot decrease to Lake Lanier's water surface level going from the Baseline Conditions (L18) to 2060 conditions (including the Proposed Project, all action and No Action Alternatives). The 1-ft decrease, again, is a result of the overall system demand increase in the future (discussed further in the Cumulative Effects Section) rather than the effects of adding the reservoir to the ACF system. To isolate the effect of the reservoir, comparison is done between the action alternatives and the No Action Alternative. When comparing the No Action Alternative (without reservoir and all future water supply comes from Lake Lanier) to the Proposed Project and its alternatives, there is generally negligible difference in water surface levels at all Corps projects. For Lake Lanier, all action alternatives involving Glades Reservoir (Alternatives 1 to 9) result in slightly higher water surface level than the No Action Alternative; however, the difference in lake levels (0.03 to 0.04 foot, or 0.4 to 0.5 inch) is not discernable to human eyes. Comparing Alternatives 1-9 (Glades alternatives) to Alternatives 10 and 11 (White Creek reservoir alternatives), the Glades alternatives offer a consistent, slightly higher increase in pool elevation at Lake Lanier. However, this increase (less than half an inch) in water level is not discernible to human eyes.

Table 4.19 Average Daily Simulated Pool Elevation for Corp Projects (ft MSL)[1]

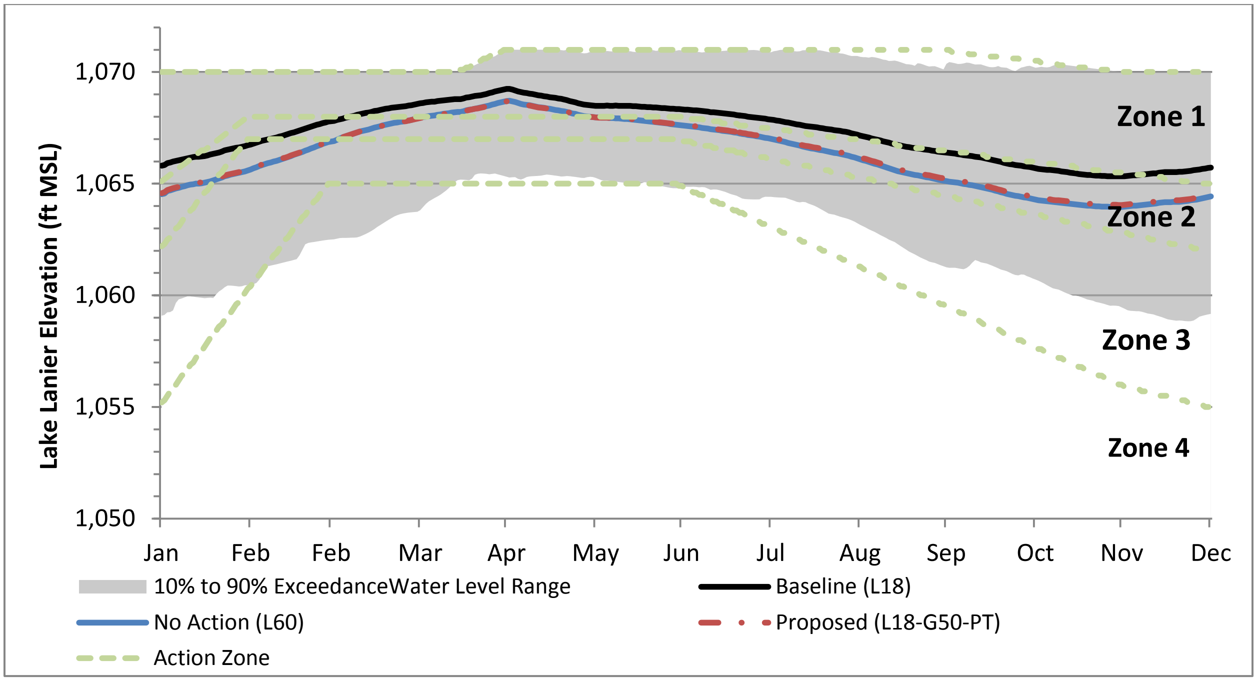
Alternative #	Alternative ID	Lake Lanier	West Point	Walter F. George	Jim Woodruff
Baseline	L18	1067.27	631.32	188.79	77.42
No Action	L60	1066.30	631.27	188.78	77.42
Proposed	L18-G50-PT	1066.34	631.27	188.78	77.42
1	L18-G42-PT	1066.34	631.27	188.78	77.42
2	L18-G42-PL	1066.34	631.27	188.78	77.42
3	L18-G42-WTP	1066.34	631.27	188.78	77.42
4	L30-G30-PT	1066.34	631.27	188.78	77.42
5	L30-G30-PL	1066.34	631.27	188.78	77.42
6	L30-G30-WTP	1066.34	631.27	188.78	77.42
7	L43-G17-PT	1066.33	631.27	188.78	77.42
8	L43-G17-PL	1066.33	631.27	188.78	77.42
9	L43-G17-WTP	1066.33	631.27	188.78	77.42
10	L43-W17-PT	1066.31	631.27	188.78	77.42
11	L43-W17-PL	1066.30	631.27	188.78	77.42

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Lake Lanier

Figure 4.38 shows that the average daily pool elevation in Lake Lanier for the No Action Alternative is nearly identical to that of the Proposed Project. In another word, there is no discernible impact on average daily lake levels whether the future demand of Hall County is met with the addition of the Glades Reservoir or with Lake Lanier only. The figure also shows that Lake Lanier would experience a drop in average daily pool elevation as the region's demand grows from Baseline (2011) to 2060 Conditions. The lake level decrease is due to the overall increases in withdrawals from the Baseline Conditions to the 2060 conditions (as shown for No Action Alternative and the Proposed Project). This would be discussed further in the Cumulative Effects section.

Figure 4.38 Average Daily Lake Lanier Pool Elevation: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2012.

[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.39 through **Figure 4.41** shows the Lake Lanier pool elevation with the Proposed Project and without a project (Baseline and No Action) during three drought periods: 1986, 2001, and 2008. On average, the addition of reservoir storage is shown to increase the daily pool elevation of Lake Lanier during most drought conditions; however, under extended severe drought conditions such as the 2007-2008 drought (**Figure 4.41)**, continued pumping from the Chattahoochee River during low flow period before Lake Lanier can recover (from previous drought periods) may slightly decrease the Lake Lanier pool elevation (when compared to No Action Alternative). The figure also shows that higher future (2060) system demand would result in an approximate 5-ft drop in pool elevation under drought conditions (**Figure 4.39** and **Figure 4.41**) under current WCM operating rules.

Figure 4.39 Lake Lanier Pool Elevation without a Project and the Proposed Project during Drought (May 1985 to May 1987)

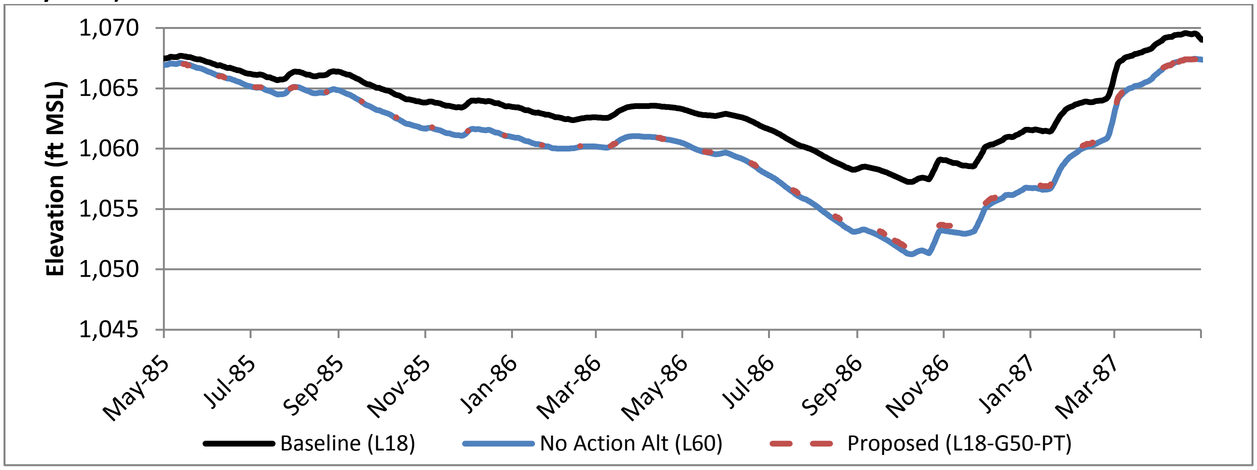


Figure 4.40 Lake Lanier Pool Elevation without a Project and the Proposed Project during Drought (May 2000 to August 2001)

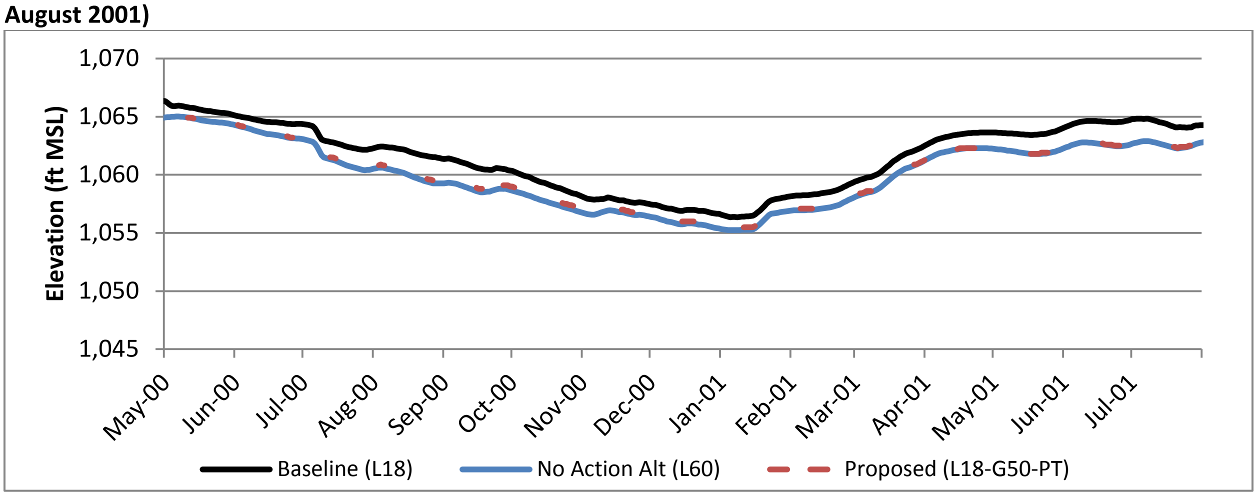


Figure 4.41 Lake Lanier Pool Elevation without a Project and the Proposed Project during Drought (April 2007 to January 2010)

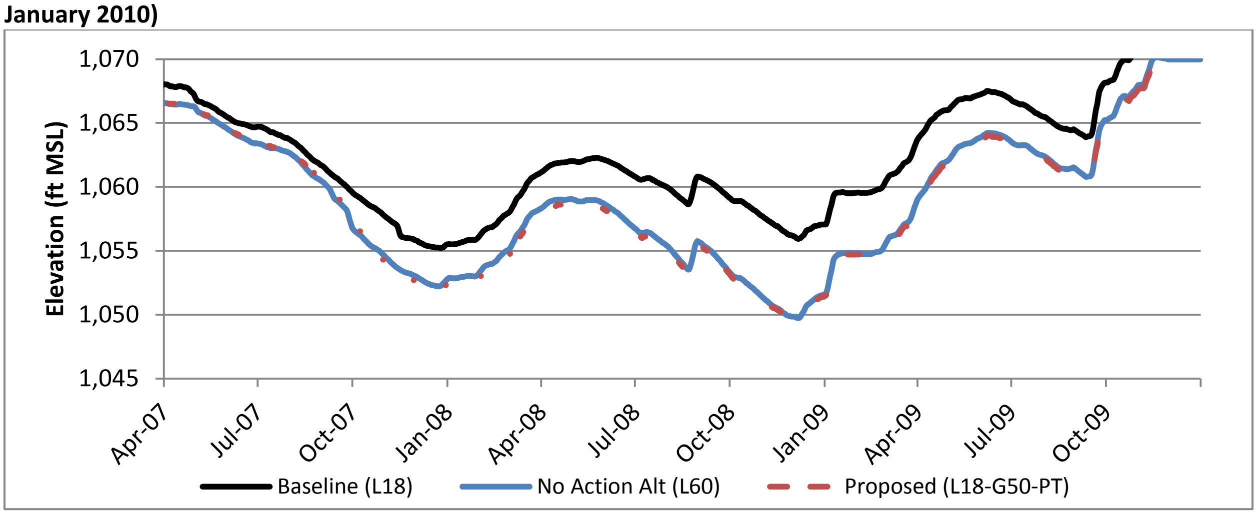


Table 4.20 summarizes the lowest lake pool elevation during the 1986, 2001 and 2008 drought periods for all alternatives. The increase in system-wide demand in 2060 is predicted to lower Lake Lanier pool elevation up to 5.5 feet under 1986 and 2008 drought conditions. This will be further discussed in the Cumulative Effects section. However, additional storage from Glades Reservoir is shown to increase the lake level by 0.5 feet (Alternatives 1-6) when compared to meeting all of the demand from Lake Lanier solely (No Action Alternative). Higher storage volume addition and higher reservoir safe yield are shown to result in higher increase in Lake Lanier water level during critical drought conditions.

Table 4.20 Lowest Lake Lanier Water Surface Elevation (ft MSL) During the 1986, 2001, and 2008 Drought Periods

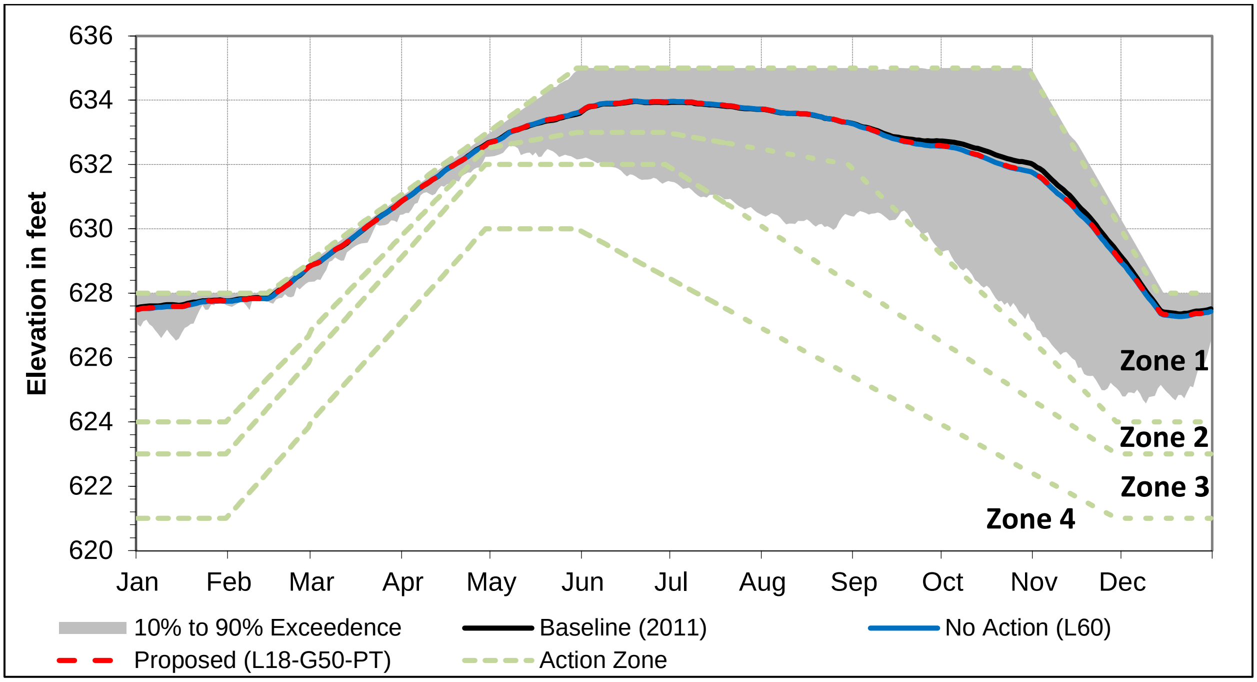
Alternative #	Alternative ID	1986 Drought[1]	2001 Drought[2]	2008 Drought[3]
Baseline	L18	1,057.2	1,056.4	1,055.5
No Action	L60	1,051.2	1,055.2	1,049.7
Proposed	L18-G50-PT	1,051.7	1,055.4	1,049.6
1	L18-G42-PT	1,051.7	1,055.4	1,049.6
2	L18-G42-PL	1,051.7	1,055.4	1,049.6
3	L18-G42-WTP	1,051.7	1,055.4	1,049.6
4	L30-G30-PT	1,051.7	1,055.4	1,049.4
5	L30-G30-PL	1,051.7	1,055.4	1,049.4
6	L30-G30-WTP	1,051.7	1,055.4	1,049.4
7	L43-G17-PT	1,051.6	1,055.4	1,049.3
8	L43-G17-PL	1,051.6	1,055.4	1,049.3
9	L43-G17-WTP	1,051.6	1,055.4	1,049.3
10	L43-W17-PT	1,051.5	1,055.4	1,050.0
11	L43-W17-PL	1,051.5	1,055.4	1,050.0

[1] Period of Analysis: January 1, 1986 through December 31, 1986.
[2] Period of Analysis: January 1, 2001 through December 31, 2001.
[3] Period of Analysis: January 1, 2008 through December 31, 2008.

West Point

The balancing of the ACF system storage reduces impacts at downstream reservoirs, as water flows from Lake Lanier to West Point Lock and Dam. **Figure 4.42** shows the average daily elevation at West Point for the Applicant's Proposed Project (L18-G50-PT) compared to the Baseline (L18) and No Action Alternative (L60). There is very little difference between the Baseline (L18) and the action alternatives.

Figure 4.42 Average Daily West Point Pool Elevation: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Table 4.21 summarizes the lowest lake pool elevation during the 1986, 2001 and 2008 drought periods for all alternatives. Due to the balancing of the system storage, the increase in system-wide demand in 2060 is predicted to increase West Point pool elevation up to 0.78 feet under 1986 and 2008 drought conditions. This will be further discussed in the Cumulative Effects section. However, there will be no change in storage for the action alternatives when compared to meeting all of the demand from Lake Lanier solely (No Action Alternative).

Table 4.21 Lowest West Point Lake Water Surface Elevation (ft MSL) During the 1986, 2001, and 2008 Drought Periods

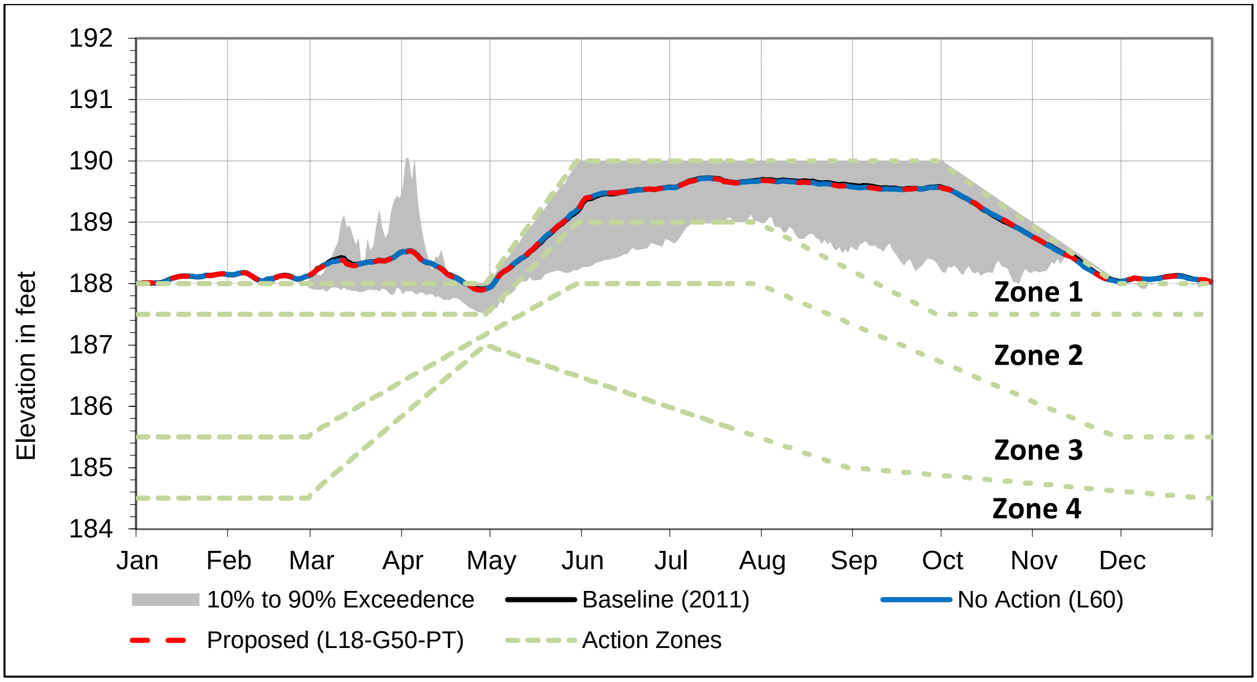
Alternative #	Alternative ID	1986 Drought[1]	2001 Drought[2]	2008 Drought[3]
Baseline	L18	626.4	623.8	623.8
No Action	L60	627.2	624.0	623.4
Proposed	L18-G50-PT	627.2	624.0	623.4
1	L18-G42-PT	627.2	624.0	623.4
2	L18-G42-PL	627.2	624.0	623.4
3	L18-G42-WTP	627.2	624.0	623.4
4	L30-G30-PT	627.2	624.0	623.4
5	L30-G30-PL	627.2	624.0	623.4
6	L30-G30-WTP	627.2	624.0	623.4
7	L43-G17-PT	627.2	624.0	623.4
8	L43-G17-PL	627.2	624.0	623.4
9	L43-G17-WTP	627.2	624.0	623.4
10	L43-W17-PT	627.2	624.0	623.4
11	L43-W17-PL	627.2	624.0	623.4

[1] Period of Analysis: January 1, 1986 through December 31, 1986.
[2] Period of Analysis: January 1, 2001 through December 31, 2001.
[3] Period of Analysis: January 1, 2008 through December 31, 2008.

Walter F. George

Figure 4.43 shows the average daily elevation at Walter F. George for the Proposed Project (L18-G50-PT) compared to the Baseline (L18) and No Action Alternative (L60). There is no discernable difference between Baseline (L18) and the action alternatives.

Figure 4.43 Average Daily Walter F. George Pool Elevation: Comparison of the Proposed Project to No Action and Baseline[1,2]



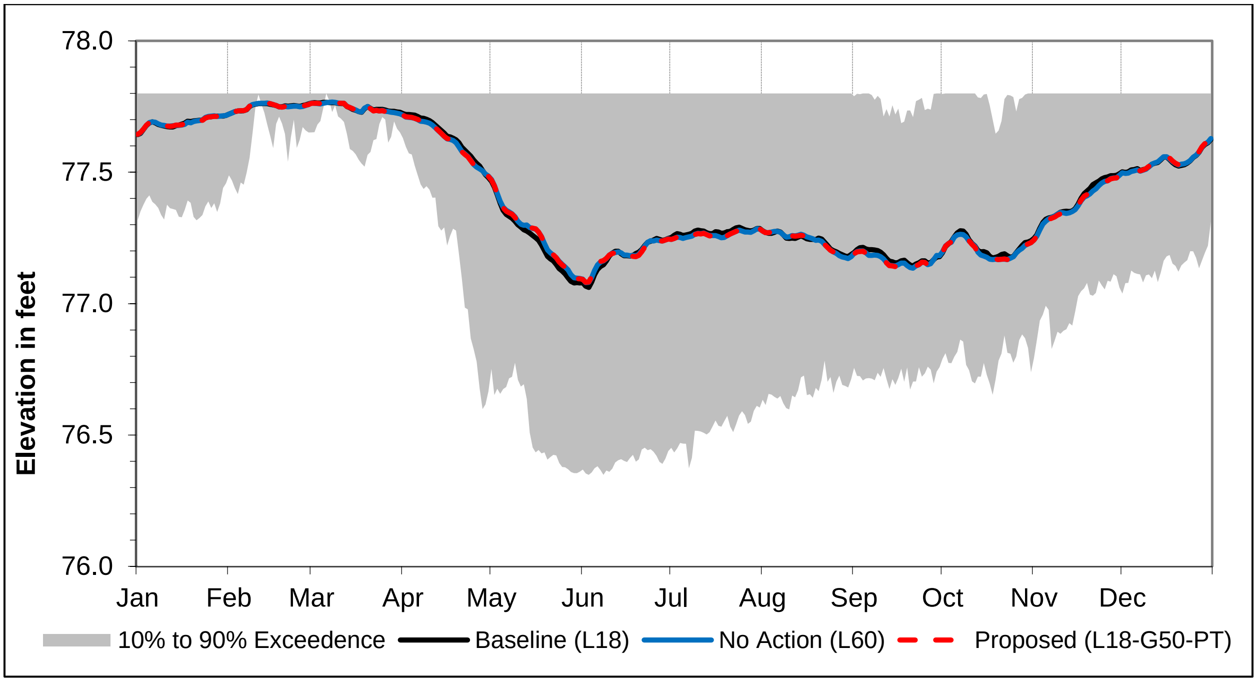
[1] Period of Analysis: January 1, 1939 through December 31, 2011.

[1] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Jim Woodruff

Figure 4.44 shows the average daily elevation at Jim Woodruff for the Applicant's Proposed Project (L18-G50-PT) compared to the Baseline (L18) and No Action Alternative (L60). There is almost no discernable difference between Baseline (L18) and the action alternatives.

Figure 4.44 Average Daily Jim Woodruff Pool Elevation: Comparison of the Proposed Project to No Action and Baseline[1,2]

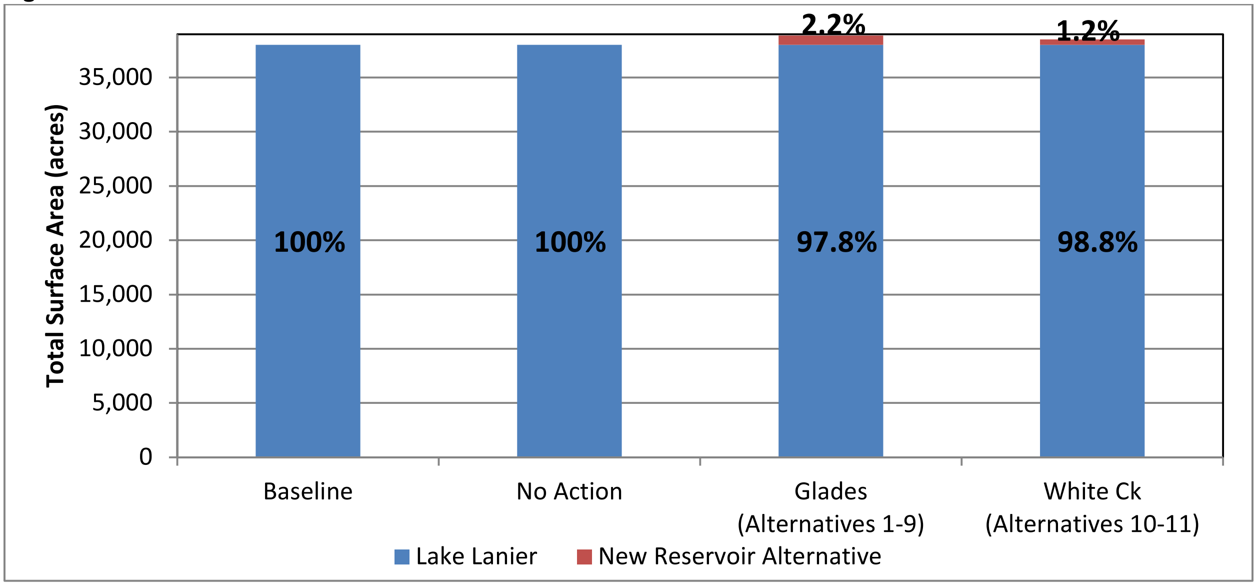


[1] Period of Analysis: January 1, 1939 through December 31, 2011.
[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

4.3.5.3 Reservoir Evaporation

Evaporation from reservoirs is calculated by multiplying a rate of evaporation by the reservoir surface area. The surface area of Lake Lanier is 38,024 acre at its normal pool elevation of 1070 ft MSL. The addition of Glades or White Creek Reservoir will add a respective additional 850 or 479 acres for water to evaporate from. However, the reservoir also offers a place to capture the precipitation that falls onto the reservoir water surface. **Figure 4.45** shows the total water surface area of each alternative set and the percent of Lake Lanier and the alternatives will add to the total water surface area. In comparison to Lake Lanier, Glades and White Creek Alternatives will not add a large amount of reservoir surface area.

Figure 4.45 Total Water Surface Area above Buford Dam at Normal Pool Elevation[1,2,3]



[1] Lake Lanier Surface Area = 38,024 ac at a normal pool elevation of 1,070 ft MSL
[2] Glades Reservoir Surface Area = 850 ac at a normal pool elevation of 1,180 ft MSL
[3] White Creek Reservoir Surface Area = 479 ac at a normal pool elevation of 1,305 ft MSL

Table 4.22 summarizes the net evaporation from the proposed reservoir's surface area**.** Net evaporation is defined as the sum of precipitation and evaporation. Positive values in the table indicate a net gain in water volume (precipitation is greater than evaporation), while negative values indicate a net loss (evaporation is greater than precipitation).

Table 4.22 Estimated Range of Net Evaporation from the Proposed Reservoir (mgd)[1, 2,3]

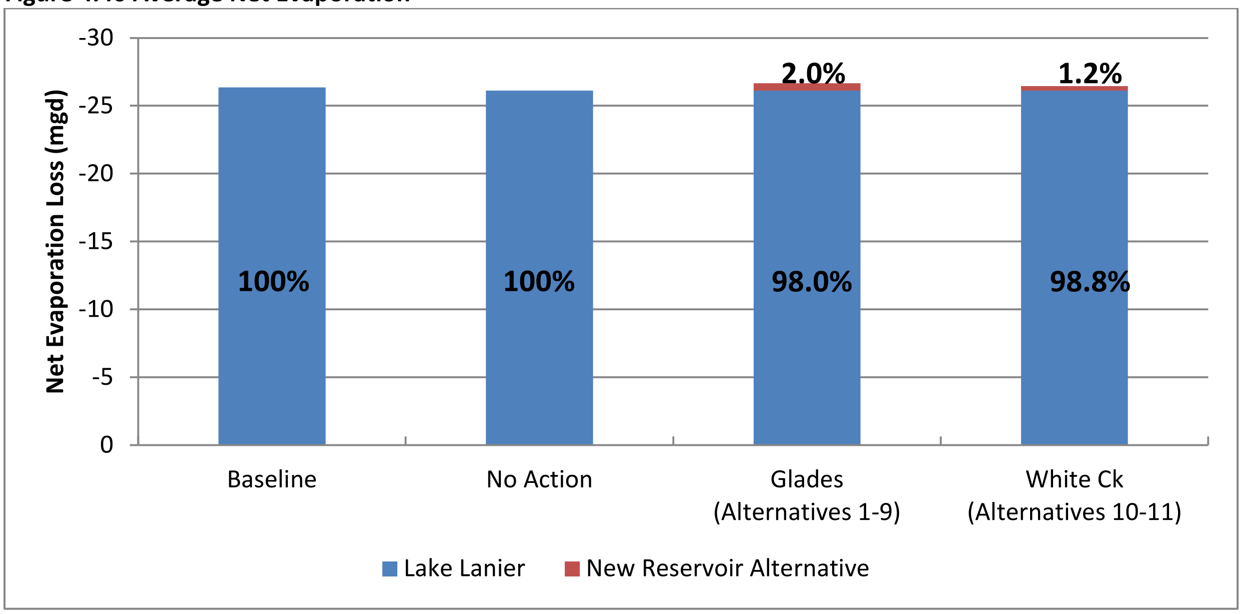
Alternative #	Alternative ID	Average Daily	Maximum Daily Gain	Maximum Daily Loss
Baseline	L18	N/A	N/A	N/A
No Action	L60	N/A	N/A	N/A
Proposed	L18-G50-PT	-0.54	4.81	-3.33
1	L18-G42-PT	-0.54	4.81	-3.33
2	L18-G42-PL	-0.54	4.81	-3.33
3	L18-G42-WTP	-0.54	4.81	-3.33
4	L30-G30-PT	-0.54	4.82	-3.35
5	L30-G30-PL	-0.54	4.82	-3.35
6	L30-G30-WTP	-0.54	4.82	-3.35
7	L43-G17-PT	-0.58	4.83	-3.40
8	L43-G17-PL	-0.54	4.82	-3.37
9	L43-G17-WTP	-0.54	4.82	-3.37
10	L43-W17-PT	-0.33	2.73	-1.92
11	L43-W17-PL	-0.33	2.73	-1.94

[1] Period of record analyzed = January 1, 1939 to December 31, 2011
[2] Based on net evaporation = the sum of precipitation (+) and evaporation (-). Negative values indicate net evaporation loss (evaporation is higher than precipitation). Positive values indicate net gain (precipitation is higher than evaporation).
[3] All estimates are for Glades Reservoir except for Alternatives 10 and 11 are the estimated evaporation from White Creek Reservoir

For the 73-year period simulated, the maximum daily net evaporation from the Proposed Project is estimated to be a net gain of approximately 4.8 mgd. On average, the daily net evaporation shows a net loss of 0.5 mgd in volume for Glades Reservoir and 0.3 mgd for White Creek Reservoir. The net evaporation is accounted for in the water balance in the safe yield analysis and also in the hydrological modeling for the ACF Basin.

Figure 4.46 shows the contribution of Lake Lanier and the alternatives to the total average net evaporation. The Glades Reservoir alternatives contribute an average of 0.5 mgd loss in evaporation, or approximately 2% of total net evaporation when combined with Lake Lanier as one system for operation. The White Creek Reservoir alternates contribute an additional 0.3 mgd average evaporation loss, or approximately 1% of total net evaporation when combined with Lake Lanier as one system for operation.

Figure 4.46 Average Net Evaporation [1,2]



[1] Period of record analyzed = January 1, 1939 to December 31, 2011

[2] Based on net evaporation = the sum of precipitation (+) and evaporation (-). Negative values indicate net evaporation loss (evaporation is higher than precipitation). Positive values indicate net gain (precipitation is higher than evaporation).

4.3.5.4 Impacts to Reservoir Discharge

The discharge from each of the Corps' projects is controlled as part of the balanced system operation of the ACF system. Releases targets are set below Lake Lanier and Jim Woodruff for Endangered Species Act (ESA) flows. **Table 4.23** summarizes the average daily discharge from each of the major Corps projects for the Proposed Project and its alternatives. There is a noticeable decrease in reservoir discharge below all Corps dams going from baseline to 2060 conditions. This decrease is attributed to overall system demand increase in 2060. When comparing the action alternatives to the No Action Alternatives (all under 2060 conditions), the modeling results show that the Proposed Project or alternatives have no effect on discharge downstream of all Corps projects.

Table 4.23 Average Daily Simulated Discharge for Corp Projects (cfs)[1]

Alternative #	Alternative ID	Lake Lanier	West Point	Walter F. George	Jim Woodruff
Baseline	L18	1,868	4,923	9,201	21,032
No Action	L60	1,792	4,842	9,125	20,890
Proposed	L18-G50-PT	1,791	4,841	9,125	20,890
1	L18-G42-PT	1,791	4,841	9,125	20,890
2	L18-G42-PL	1,791	4,841	9,125	20,890
3	L18-G42-WTP	1,791	4,841	9,125	20,890
4	L30-G30-PT	1,791	4,841	9,125	20,890
5	L30-G30-PL	1,791	4,841	9,125	20,890
6	L30-G30-WTP	1,791	4,841	9,125	20,890
7	L43-G17-PT	1,791	4,841	9,125	20,890
8	L43-G17-PL	1,791	4,841	9,125	20,890
9	L43-G17-WTP	1,791	4,841	9,125	20,890
10	L43-W17-PT	1,792	4,841	9,125	20,890
11	L43-W17-PL	1,792	4,841	9,125	20,890

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Table 4.24 shows the percent change in discharge for the Proposed Project and its alternatives from the Baseline Conditions (L18) and from the No Action Alternative (L60). There would be a decrease in reservoir discharge attributed to the overall increase in system demand (Cumulative Effects) as compared to the 2011 Baseline Conditions. In particular, the discharge below the Jim Woodruff dam is predicted to decrease 0.7% from 2011 to 2060 conditions. There is no discernible difference in reservoir discharge in all projects between the No Action (without reservoir) and action alternatives (with reservoir) under 2060 conditions. This shows that the addition of the reservoir (Glades or White) does not affect the downstream discharge at Corps projects.

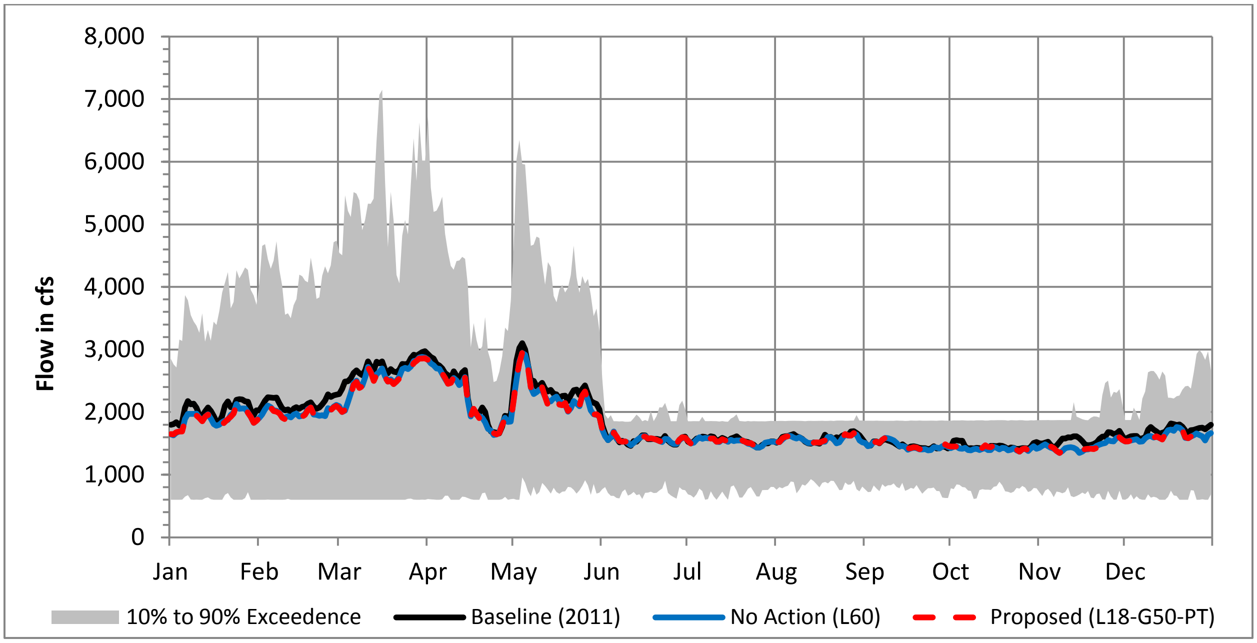
Table 4.24 Percent Change in Average Daily Simulated Discharge from Baseline/No Action for Corp Projects[1]

Alternative #	Alternative ID	Lake Lanier	West Point	Walter F. George	Jim Woodruff
Baseline	L18	---	---	---	---
No Action	L60	-4.1%/0.0%	-1.6%/0.0%	-0.8%/0.0%	-0.7%/0.0%
Proposed	L18-G50-PT	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
1	L18-G42-PT	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
2	L18-G42-PL	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
3	L18-G42-WTP	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
4	L30-G30-PT	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
5	L30-G30-PL	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
6	L30-G30-WTP	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
7	L43-G17-PT	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
8	L43-G17-PL	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
9	L43-G17-WTP	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
10	L43-W17-PT	-4.1%/0.0%	-1.7%/0.0%	-0.8%/0.0%	-0.7%/0.0%
11	L43-W17-PL	-0.1%/0.0%	0.0%/0.0%	0.0%/0.0%	0.0%/0.0%

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

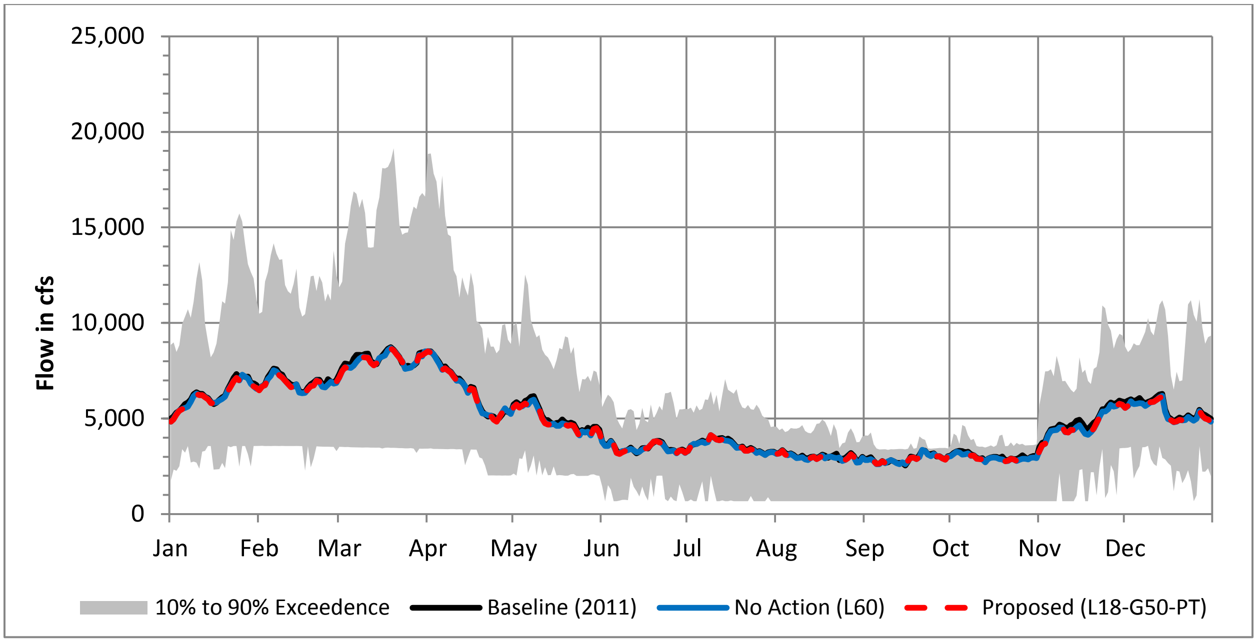
Figure 4.47 through **Figure 4.50** illustrate the impact of the Proposed Project (L18-G50-PT) when compared to the Baseline Conditions (L18) and to the No Action Alternative (L60) at each of the Corps projects. There is a decrease in the average daily discharge from Buford Dam in comparison to the Baseline Conditions, but there is no change in comparison to the No Action Alternative (**Figure 4.47**). There is no difference in comparison to the Baseline Conditions or the No Action Alternative in the average daily discharge from the dams downstream of Buford Dam.

Figure 4.47 Average Daily Discharge from Buford Dam: Comparison of the Proposed Project to No Action and Baseline[1,2]



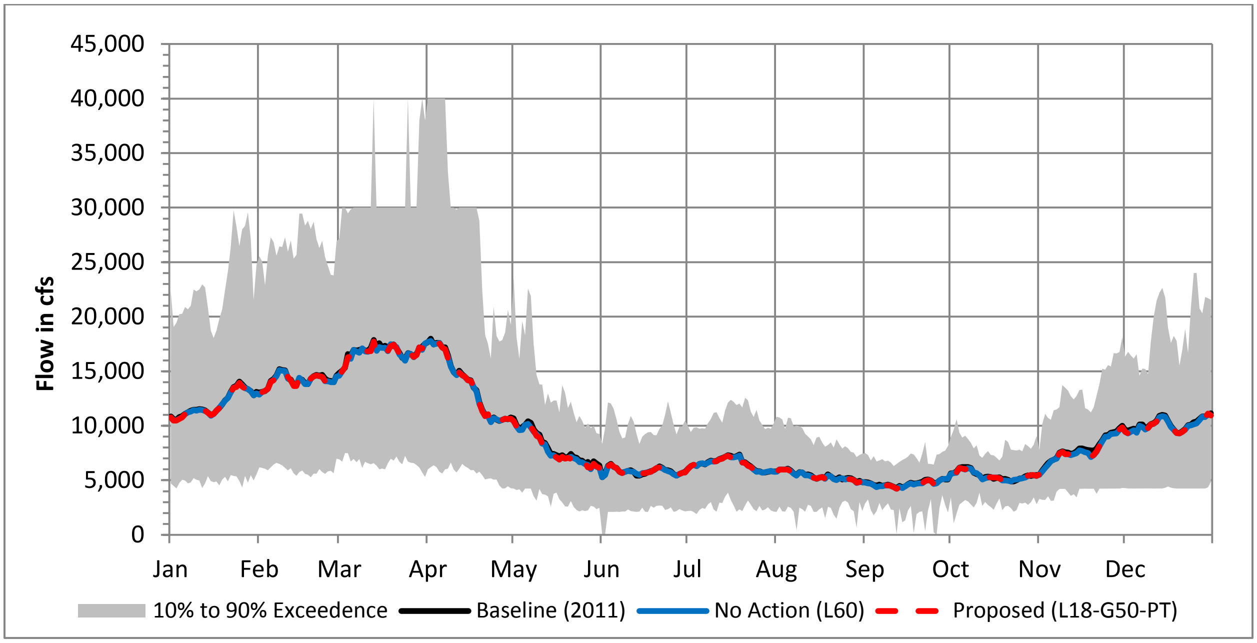
1 Period of Analysis: January 1, 1939 through December 31, 2011.
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.48 Average Daily Discharge from West Point Dam: Comparison of the Proposed Project to No Action and Baseline[1,2]



1 Period of Analysis: January 1, 1939 through December 31, 2011.
2 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

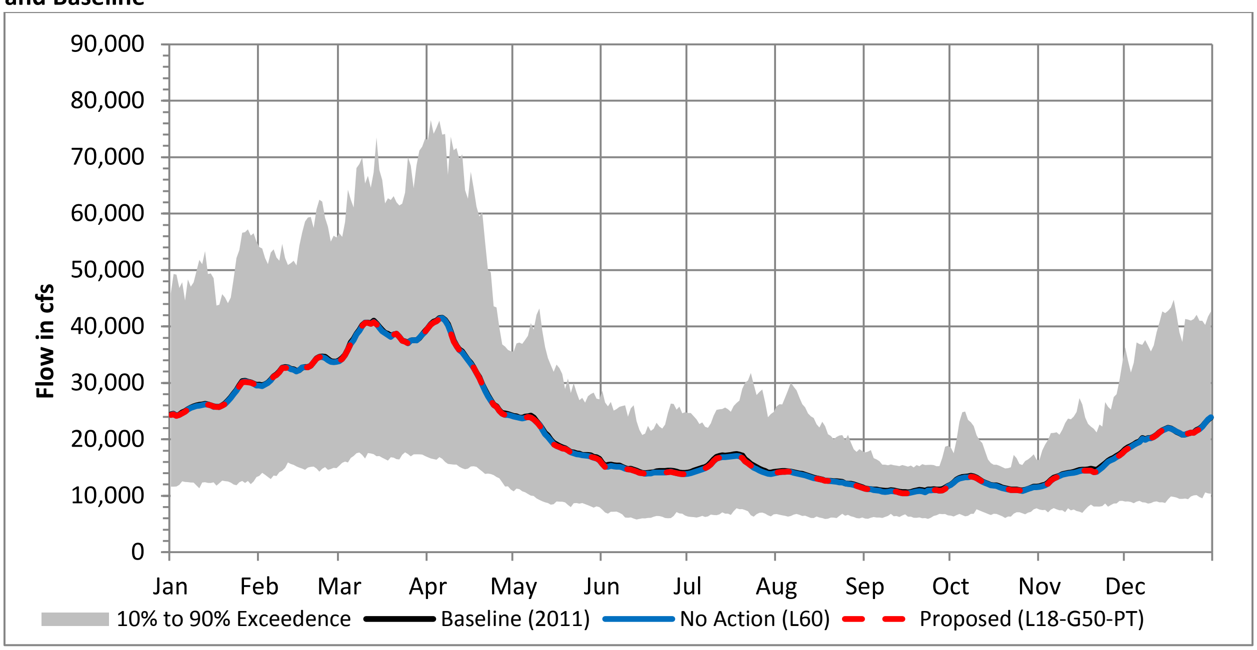
Figure 4.49 Average Daily Discharge from Walter F. George Dam: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

Figure 4.50 Average Daily Discharge from Jim Woodruff Dam: Comparison of the Proposed Project to No Action and Baseline[1,2]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

[2] 10% to 90% exceedance flow range: top of range means that only 10% of the time the baseline flow exceeds the shown value on any given day; lowest of range means that 90% of the time the baseline flow exceeds the shown value on the given day.

4.3.5.5 Impacts to Hydropower

Energy Generation

Table 4.25 summarizes the estimated average daily energy generation at the major Corps projects. The average daily energy generation would decrease slightly when the system demands increase from the Baseline to 2060 conditions. This magnitude of energy generation impact lessens as the project moves downstream. There would be no effect on energy generation when comparing the Proposed Project and its action alternatives to the No Action Alternative. In another word, regardless of Hall County's 2060 demand being met by Glades or Lake Lanier, there would be no effect on hydropower generation.

Table 4.25 Average Daily Energy Generation from Corps Projects (MWh)[1]

Alternative #	Alternative ID	Buford	West Pt	WF George	Woodruff
Baseline	L18	352	489	1,303	698
No Action	L60	330	480	1,294	695
Proposed	L18-G50-PT	329	480	1,294	695
1	L18-G42-PT	329	480	1,294	695
2	L18-G42-PL	329	480	1,294	695
3	L18-G42-WTP	329	480	1,294	695
4	L30-G30-PT	329	480	1,294	695
5	L30-G30-PL	329	480	1,294	695
6	L30-G30-WTP	329	480	1,294	695
7	L43-G17-PT	329	480	1,294	695
8	L43-G17-PL	329	480	1,294	695
9	L43-G17-WTP	329	480	1,294	695
10	L43-W17-PT	329	480	1,294	695
11	L43-W17-PL	329	480	1,294	695

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Table 4.26 summarizes the percent change in the estimated average daily energy generation at the major Corps projects. The energy generation from Buford Dam is estimated to decrease approximately 6% from the Baseline Conditions. There is a very minor difference (0.1% or less) between the No Action Alternative and the action alternatives. This indicates that the addition of Glades or White Creek Reservoir would reduce the overall system energy production by less than 0.1% (as compared to the No Action Alternative).

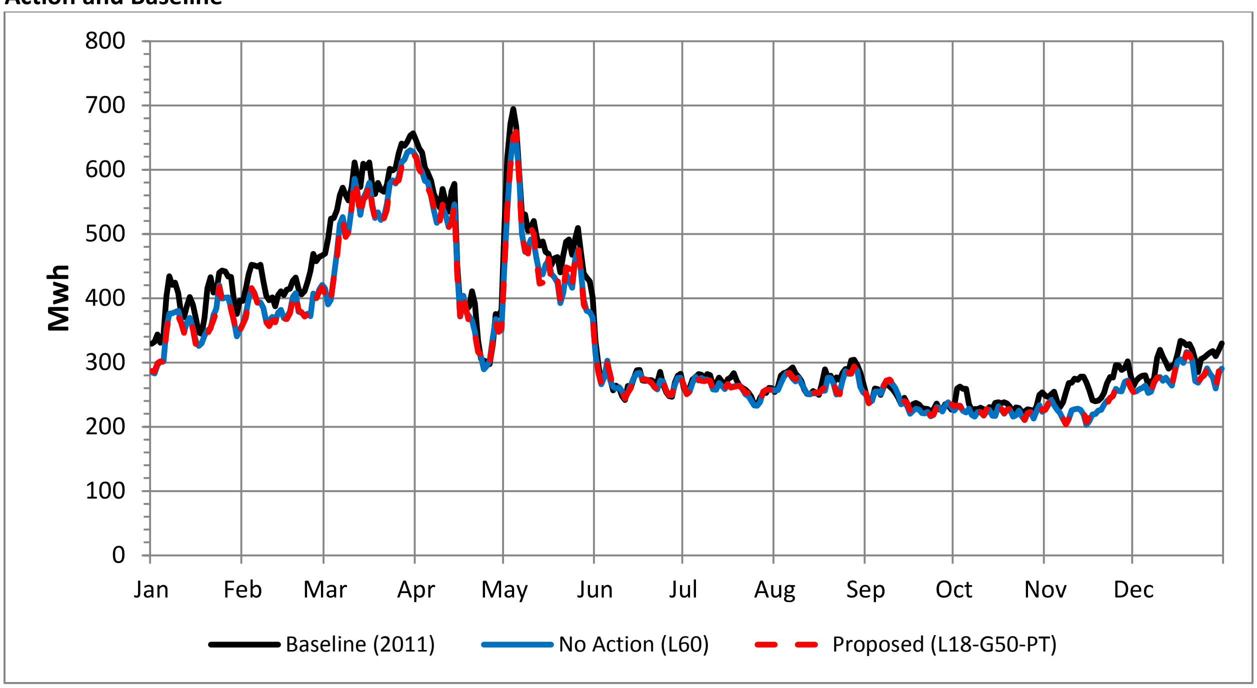
Table 4.26 Percent Change in Average Annual Energy Generation from Corps Project for Baseline/No Action[1]

Alternative #	Alternative ID	Buford	West Pt	WF George	Woodruff
Baseline	L18	---	---	---	---
No Action	L60	-6.3%/---	-1.8%/---	-0.7%/--	-0.4%/---
Proposed	L18-G50-PT	-6.3%/-0.1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
1	L18-G42-PT	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
2	L18-G42-PL	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
3	L18-G42-WTP	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
4	L30-G30-PT	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
5	L30-G30-PL	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
6	L30-G30-WTP	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
7	L43-G17-PT	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
8	L43-G17-PL	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
9	L43-G17-WTP	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
10	L43-W17-PT	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%
11	L43-W17-PL	-6.3%/-0. 1%	-1.8%/0.0%	-0.7%/0.0%	-0.4%/0.0%

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Figure 4.51 shows the average daily energy generation at Buford Dam for without a project (Baseline and No Action) and with the Proposed Project. Most of the difference from the Baseline Conditions is seen in the winter months. There is almost no change from the Baseline Conditions to the No Action Alternative during the summer months.

Figure 4.51 Average Daily Energy Generation from Buford Dam: Comparison of the Proposed Project to the No Action and Baseline[1]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Power Head Capacity

Table 4.27 lists the average daily power capacity at the major Corps projects. The modeling results indicate that the power capacity at Buford Dam would experience a small decrease from the Baseline to the action alternatives. However, no impact is predicted in power capacity at projects below Buford Dam. In addition, there is no difference between the No Action and the action alternatives under 2060 conditions.

Table 4.27 Average Daily Power Capacity from the Major Corps Projects (MW)[1]

Alternative #	Alternative ID	Buford	West pt	WF George	Woodruff
Baseline	---	115.5	85.4	167.5	38.6
Applicant's	L18-G50-PT	114.7	85.4	167.5	38.6
1	L18-G42-PT	114.8	85.4	167.5	38.6
2	L18-G42-PL	114.8	85.4	167.5	38.6
3	L18-G42-WTP	114.8	85.4	167.5	38.6
4	L30-G30-PT	114.8	85.4	167.5	38.6
5	L30-G30-PL	114.8	85.4	167.5	38.6
6	L30-G30-WTP	114.8	85.4	167.5	38.6
7	L43-G17-PT	114.8	85.4	167.5	38.6
8	L43-G17-PL	114.7	85.4	167.5	38.6
9	L43-G17-WTP	114.7	85.4	167.5	38.6
10	L43-W17-PT	114.7	85.4	167.5	38.6
11	L43-W17-PL	114.7	85.4	167.5	38.6
No Action	L60	114.7	85.4	167.5	38.6

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Table 4.28 summarizes the average daily head at the major Corps projects. The modeling results indicate that the average daily head at Buford Dam would experience a small decrease from the Baseline to the action alternatives. However, no impact is predicted in power capacity at projects below Buford Dam. In addition, there is no difference between the No Action and the action alternatives under 2060 conditions.

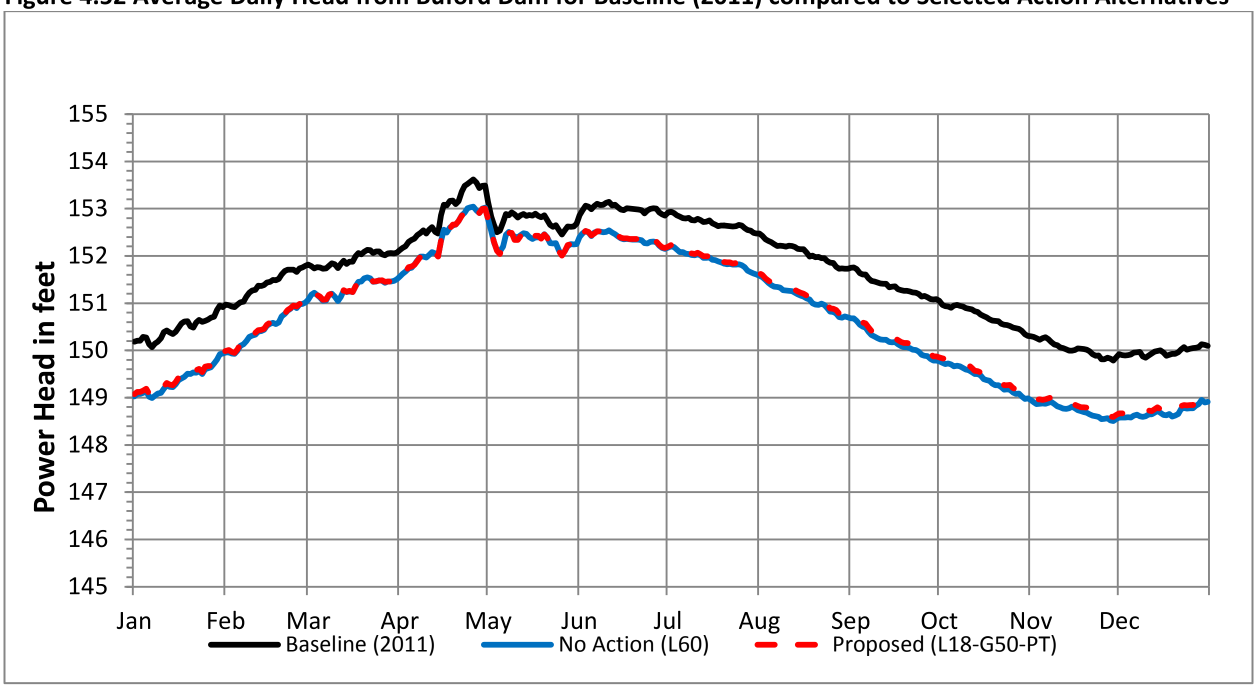
Table 4.28 Average Daily Power Head from the Major Corps Projects (ft)[1]

Alternative #	Alternative ID	Buford	West pt	WF George	Woodruff
Baseline	---	151.6	70.0	82.6	30.0
Applicant's	L18-G50-PT	150.7	69.9	82.6	30.0
1	L18-G42-PT	150.7	69.9	82.6	30.0
2	L18-G42-PL	150.7	69.9	82.6	30.0
3	L18-G42-WTP	150.7	69.9	82.6	30.0
4	L30-G30-PT	150.7	69.9	82.6	30.0
5	L30-G30-PL	150.7	69.9	82.6	30.0
6	L30-G30-WTP	150.7	69.9	82.6	30.0
7	L43-G17-PT	150.7	69.9	82.6	30.0
8	L43-G17-PL	150.7	69.9	82.6	30.0
9	L43-G17-WTP	150.7	69.9	82.6	30.0
10	L43-W17-PT	150.7	69.9	82.6	30.0
11	L43-W17-PL	150.7	69.9	82.6	30.0
No Action	L60	150.7	69.9	82.6	30.0

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Figure 4.52 compares the average daily power head at Buford Dam for Baseline, No Action Alternative, and with the Proposed Project. The modeling results indicate that the average daily head at Buford Dam would experience a small decrease from the Baseline to 2060 conditions with all action alternatives. However, no impact is predicted in power head at projects below Buford Dam. In addition, there is no difference between the No Action and the action alternatives under 2060 conditions.

Figure 4.52 Average Daily Head from Buford Dam for Baseline (2011) compared to Selected Action Alternatives[1]



[1] Period of Analysis: January 1, 1959 through December 31, 2012.

4.3.5.6 Impacts to Recreation

Table 4.29 summarizes the number of times the pool levels fall below the designated recreation impact level (RIL) for each lake (see descriptions in Chapter 3) for the 73-year of record analyzed (each year is counted once as long as the lake level falls below the RII regardless of duration). Based on this table, the majority of the recreational impacts of the Proposed Project and its alternatives would be limited to Lake Lanier. Impact durations are further analyzed below.

Table 4.30 summarizes the percent of time the pool falls below the designated RIL for each lake for the 73-year of record analyzed. The percent of time the Lake Lanier pool level falls below each recreation level increases for the No Action and all action alternatives under 2060 conditions. Comparing the No Action Alternative to Alternatives 1 through 9, the Glades Reservoir with various proposed yields has a beneficial impact (reduced number of times the lake level is predicted to fall below the RIL) for Lake Lanier. The Proposed Project and alternatives have no recreational impacts on for lakes downstream of Lake Lanier when compared to No Action Alternatives under 2060 conditions. The overall system demand increase from 2011 to 2060 conditions would have an adverse (cumulative) impact on recreation at all projects.

Table 4.29 Number of Times Pool Falls Below RILs at Each Federal Reservoir[1]

		Lake Lanier[2]			West Point[3]			WF George[4]			Jim Woodruff[5]		
Alt #	Alternative ID	Initial	Recreation	Water Access Limited	Initial	Recreation	Water Access Limited	Initial	Recreation	Water Access Limited	Initial Recreation	Generator Intake	All Facilities Closed
Baseline	L18	54	21	17	73	73	21	5	1	0	3	0	0
No Action	L60	65	38	20	73	73	22	6	1	0	3	0	0
Proposed	L18-G50-PT	65	35	20	73	73	22	6	1	0	3	0	0
1	L18-G42-PT	65	36	20	73	73	22	6	1	0	3	0	0
2	L18-G42-PL	65	36	20	73	73	22	6	1	0	3	0	0
3	L18-G42-WTP	65	36	20	73	73	22	6	1	0	3	0	0
4	L30-G30-PT	65	36	20	73	73	22	7	1	0	3	0	0
5	L30-G30-PL	65	36	20	73	73	22	7	1	0	3	0	0
6	L30-G30-WTP	65	36	20	73	73	22	7	1	0	3	0	0
7	L43-G17-PT	65	36	20	73	73	22	7	1	0	3	0	0
8	L43-G17-PL	65	36	20	73	73	22	7	1	0	3	0	0
9	L43-G17-WTP	65	36	20	73	73	22	7	1	0	3	0	0
10	L43-W17-PT	65	38	20	73	73	22	6	1	0	3	0	0
11	L43-W17-PL	66	39	20	73	73	22	6	1	0	3	0	0

[1] Period of Analysis: January 1, 1939 through December 31, 2011.
[2] Lake Lanier: Initial Impact Level (IIL)=1066 ft MSL; RIL=1063 ft MSL; Water Access Limited Level (WALL)= 1060 ft MSL
[3] West Point Lake: IIL=632.5 ft MSL; RIL=629 ft MSL; WALL= 627 ft MSL
[4] Walter F George Lake: IIL=187 ft MSL; RIL=185 ft MSL; WALL= 184 ft MSL
[5] Lake Seminole: Initial RIL=76 ft MSL; Generator Intake Impact Level=74.5 ft MSL; All Facilities Closed Level= 73 ft MSL

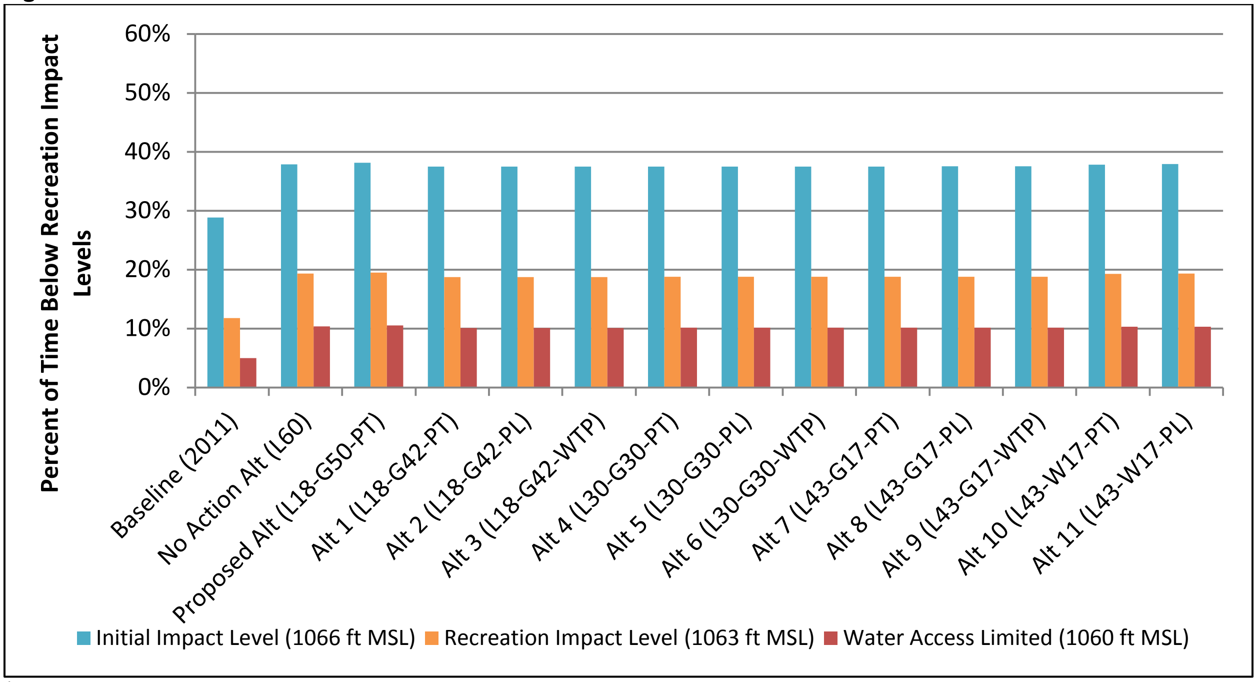
Table 4.30 Percent of Time the Pool Falls Below RILs at Each Federal Reservoir[1]

		Lake Lanier[2]			West Point[3]			WF George[4]			Jim Woodruff[5]		
Alt #	Alternative ID	Initial	Recreation	Water Access Limited	Initial	Recreation	Water Access Limited	Initial	Recreation	Water Access Limited	Initial Recreation	Generator Intake	All Facilities Closed
Baseline	L18	28.9%	11.8%	5.0%	57.7%	28.9%	4.3%	1.6%	0.1%	0.0%	0.3%	0.0%	0.0%
No Action	L60	38.1%	19.5%	10.5%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
Proposed	L18-G50-PT	37.5%	18.7%	10.1%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
1	L18-G42-PT	37.5%	18.7%	10.1%	58.3%	28.9%	5.3%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
2	L18-G42-PL	37.5%	18.7%	10.1%	58.3%	28.9%	5.3%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
3	L18-G42-WTP	37.5%	18.8%	10.1%	58.3%	28.9%	5.3%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
4	L30-G30-PT	37.5%	18.8%	10.1%	58.3%	28.9%	5.4%	1.9%	0.3%	0.0%	0.9%	0.0%	0.0%
5	L30-G30-PL	37.5%	18.8%	10.1%	58.3%	28.9%	5.4%	1.9%	0.3%	0.0%	0.9%	0.0%	0.0%
6	L30-G30-WTP	37.5%	18.8%	10.1%	58.3%	28.9%	5.4%	1.9%	0.3%	0.0%	0.9%	0.0%	0.0%
7	L43-G17-PT	37.5%	18.8%	10.1%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
8	L43-G17-PL	37.5%	18.8%	10.1%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
9	L43-G17-WTP	37.8%	19.2%	10.3%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
10	L43-W17-PT	37.9%	19.3%	10.3%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%
11	L43-W17-PL	37.9%	19.3%	10.3%	58.3%	28.9%	5.4%	1.8%	0.3%	0.0%	0.9%	0.0%	0.0%

[1] Period of Analysis: January 1, 1939 through December 31, 2011.
[2] Lake Lanier: IIL=1066 ft MSL; RIL=1063 ft MSL; WALL= 1060 ft MSL
[3] West Point Lake: IIL=632.5 ft MSL; RIL=629 ft MSL; WALL= 627 ft MSL
[4] Walter F George Lake: IIL=187 ft MSL; RIL=185 ft MSL; WALL= 184 ft MSL
[5] Lake Seminole: Initial RIL=76 ft MSL; Generator Intake Impact Level=74.5 ft MSL; All Facilities Closed Level= 73 ft MSL

Figure 4.53 shows the percent of time the pool falls below each RIL in Lake Lanier. The percent of time the Lake Lanier pool level falls below each recreation level increases for the No Action and all action alternatives under 2060 conditions. Comparing the No Action Alternative to Alternatives 1 through 9, the Glades Reservoir with various proposed yields has a beneficial impact (reduced percent of time the lake level is predicted to fall below the RIL) for Lake Lanier.

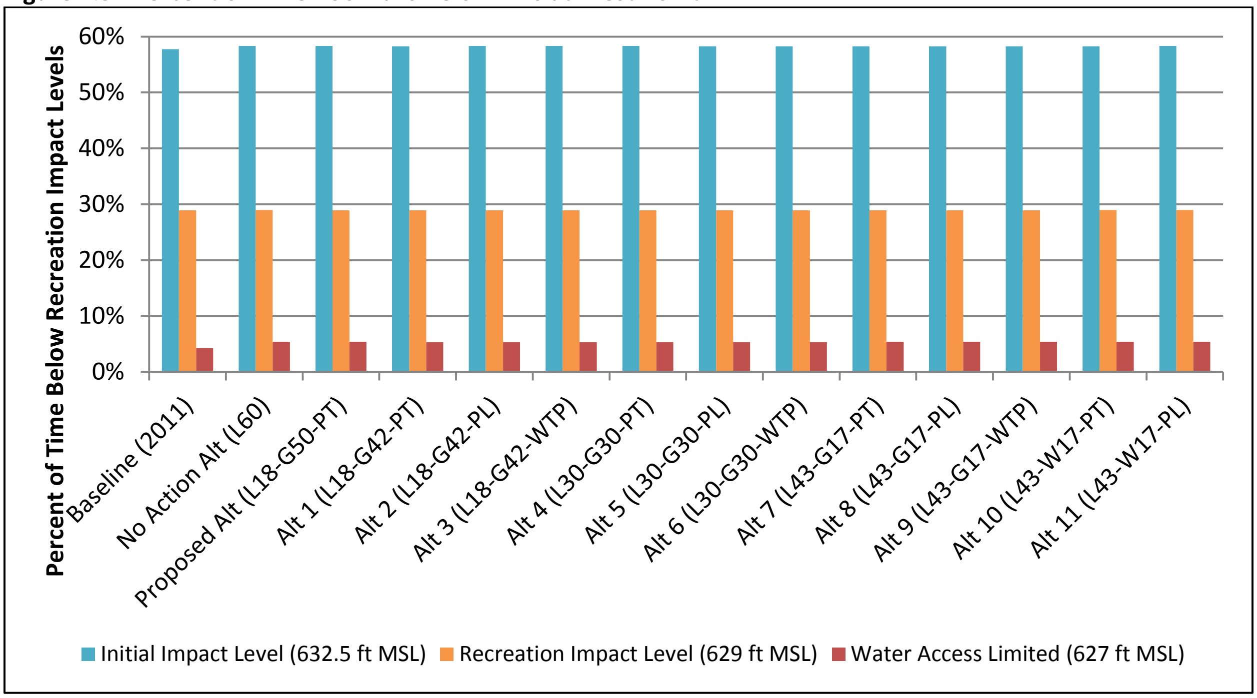
Figure 4.53 Percent of Time Pool Falls Below RILs at Lake Lanier[1]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Figure 4.54 shows the percent of time the pool falls below each RIL at West Point Lake. For the 73-year of record analyzed, West Point Lake under Baseline Conditions (L18) is estimated to fall below the IIL (632.5 ft MSL) 57.7% of the time, below the RIL (629 ft MSL) 28.9% of the time, and below the WALL (627 ft MSL) 4.3% of the time. The percent of time the West Point pool level falls below each recreation level increases slightly under 2060 conditions for all action and No Action Alternatives. However, there is no difference between the No Action Alternative and the Proposed Project under 2060 conditions, both were predicted to fall below the IIL 58.3% of the time.

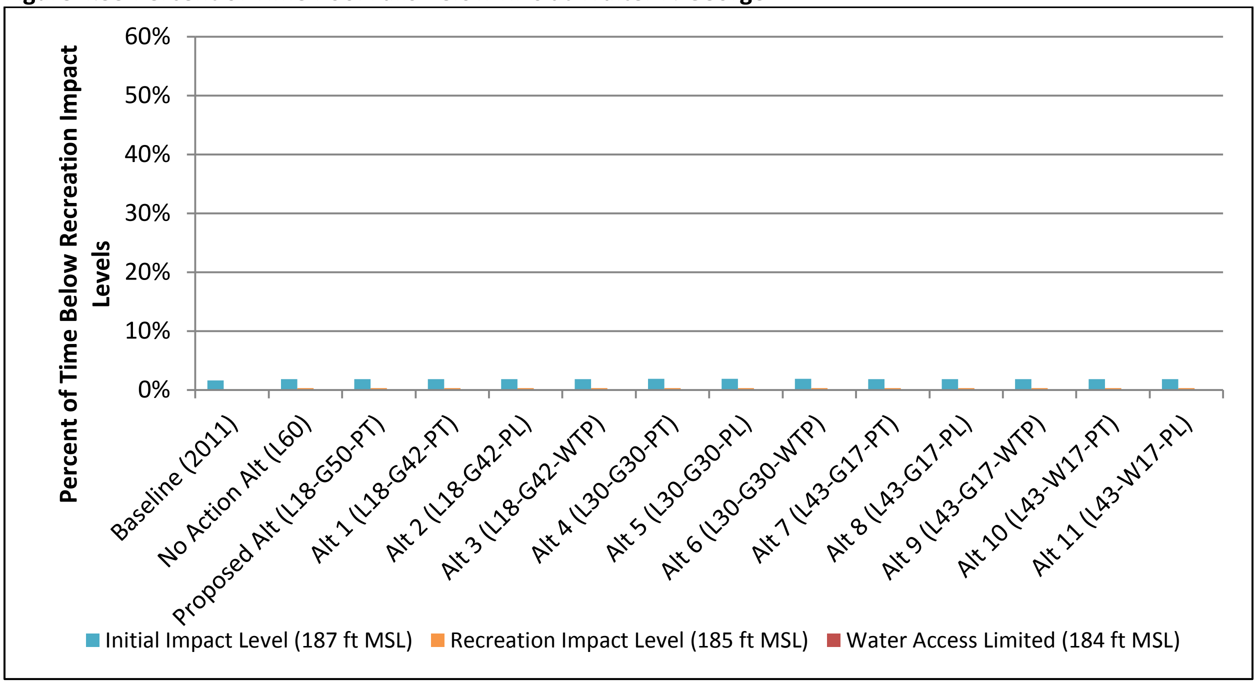
Figure 4.54 Percent of Time Pool Falls Below RILs at West Point[1]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Figure 4.55 shows the percent of time the pool falls below each RIL at Walter F. George Lake. For the 73-year of record analyzed, Walter F. George Lake under Baseline Conditions (L18) is estimated to fall below the IIL (187 ft MSL) 1.6% of the time, below the RIL (185 ft MSL) 0.1% of the time, and below the WALL (184 ft MSL) 0.0% of the time. The percent of time the Walter F. George pool level falls below each recreation level increases slightly under 2060 conditions for all action and No Action Alternatives. However, there is no difference between the No Action Alternative and the Proposed Project under 2060 conditions, both were predicted to fall below the IIL 1.8% of the time.

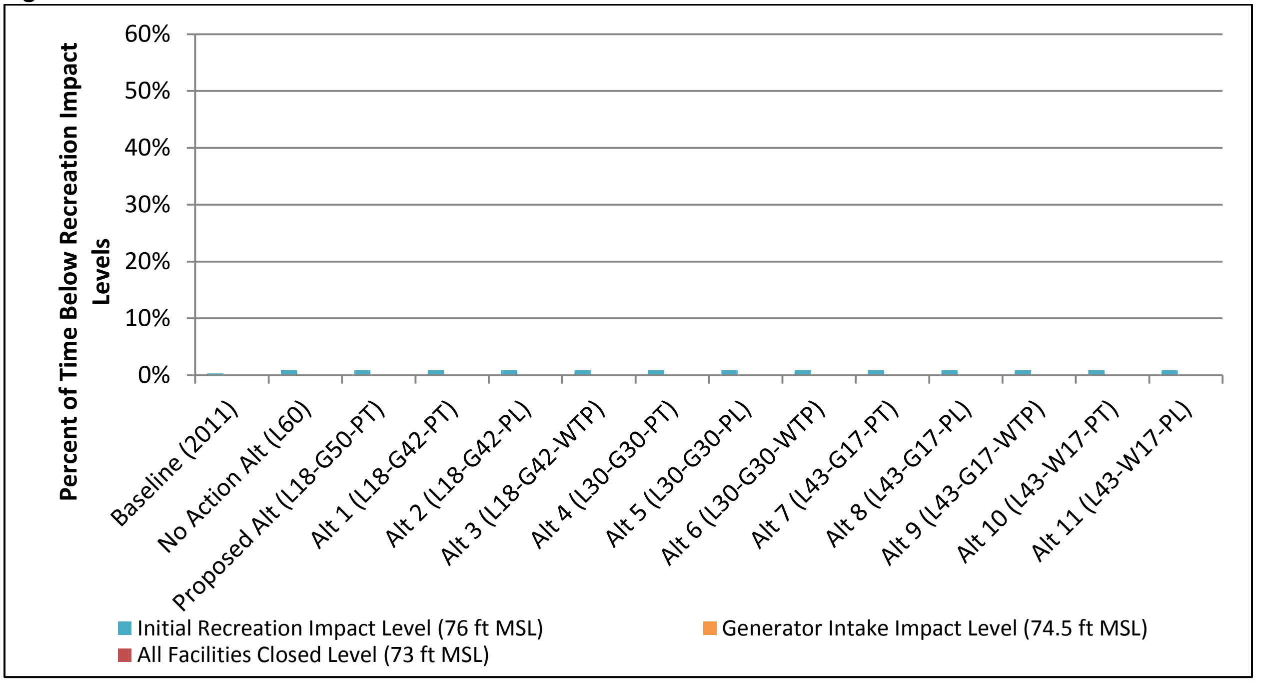
Figure 4.55 Percent of Time Pool Falls Below RILs at Walter F. George[1]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

Figure 4.56 shows the percent of time the pool falls below each RIL in Jim Woodruff. For the 73-year of record analyzed, Walter F. George Lake under Baseline Conditions (L18) is estimated to fall below the Initial RIL (76 ft MSL) 0.3% of the time, and 0.0% for the Generator Intake Impact Level (74.5 ft MSL), and 0.0% under the All Facilities Closed Level (73 ft MSL). The percent of time the Jim Woodruff pool level falls below each recreation level increases slightly under 2060 conditions for all action and No Action Alternatives. However, there is no difference between the No Action Alternative and the Proposed Project under 2060 conditions, both were predicted to fall below the IIL 0.9% of the time.

Figure 4.56 Percent of Time Pool Falls Below RILs at Jim Woodruff[1]



[1] Period of Analysis: January 1, 1939 through December 31, 2011.

4.3.5.7 Impacts to Navigation

As shown in previous sections, there would be a light decrease in streamflow and reservoir discharge below Lake Lanier resulting from overall system demand increase from Baseline to 2060 conditions. This slight decrease in streamflow is not expected to affect navigation. There would be no discernable impact to streamflow or elevation below Lake Lanier resulting from the Proposed Project or alternatives, and because of this, there would be no discernable impacts to navigation.

4.3.5.8 Drought Operations

Table 4.31 presents a summary of the estimated percent of time that drought operations are in effect and the number of times that drought operations are triggered for the alternatives evaluated, based on current ACF system operating rules. The increase in total system demand would increase the percentage of time that the system is under “drought operation” (10.8% under 2060 conditions) when compared to the Baseline (6.1% under 2011 conditions). The model predicted that drought operation would be triggered five times under 2060 conditions as compared to three times under the Baseline Conditions. With the addition of Glades Reservoir (Alternatives 1 through 9), the system spends less time in drought operation as compared to the No Action Alternative. The White Creek Reservoir alternatives (Alternatives 10 and 11) have neither beneficial nor adverse impact when compared to the No Action Alternative. There is no difference in the number of times that drought operations are triggered for all the alternatives evaluated.

Table 4.31 Drought Operations Time and Trigger[1]

Alternative #	Alternative ID	Drought Operations, % of Time	Drought Operations, # of Triggers
Baseline	---	6.1%	3
Applicant's	L18-G50-PT	10.8%	5
1	L18-G42-PT	10.6%	5
2	L18-G42-PL	10.6%	5
3	L18-G42-WTP	10.6%	5
4	L30-G30-PT	10.6%	5
5	L30-G30-PL	10.6%	5
6	L30-G30-WTP	10.6%	5
7	L43-G17-PT	10.5%	5
8	L43-G17-PL	10.6%	5
9	L43-G17-WTP	10.6%	5
10	L43-W17-PT	10.8%	5
11	L43-W17-PL	10.8%	5
No Action	L60	10.8%	5

[1] Period of Analysis: January 1, 1939 through December 31, 2011.

4.3.6 Groundwater

All of the alternatives analyzed include groundwater as a component to meet Hall County's 2060 water supply need. Hall County estimated its existing groundwater use to be between 2 to 3 mgd. The county is permitted to withdraw a total of 3.4 mgd on an annual average basis (including permitted non-farm withdrawals of 2.7 mgd plus an estimated permitted farm use of 0.7 mgd). It is estimated that an additional 0.4 to 2.1 mgd of groundwater supply could potentially be developed in the future in areas not served by Hall County's public water systems. On average, approximately 4.7 mgd of total groundwater supplies could be potentially available in Hall County in 2060 (Groundwater Availability Technical Memorandum). This additional level of groundwater availability (1.3 mgd) is considered a water supply component in all alternatives. Given the low productivity/yield of the crystalline rock aquifer, the Proposed Project and its alternatives is expected to have no effects on Hall County's groundwater supply. A number of groundwater users, mostly single-family residential and small community water systems, will likely discontinue groundwater use when public water becomes available in their vicinity in the future.

4.4 Surface Water Quality

This section provides a review of the existing water quality standards and potential impacts caused by the proposed pumping from the Chattahoochee River for the purpose of filling and operating Glades Reservoir.

The water quality impact evaluation is organized based on:

- Water quality in the segment of the Chattahoochee River directly below the proposed raw water intake and above the Lake Lanier boundary
- Water quality in the proposed reservoir
- Water quality in Lake Lanier and downstream

4.4.1 Water Quality in Chattahoochee River Below Proposed Lake Intake and Above Lake Lanier

This sub-section summarizes the evaluation of potential water quality impacts to the segment of the Chattahoochee River directly below the proposed raw water intake and above the Lake Lanier boundary. Parameters evaluated are limited to the water quality parameters that are potentially affected by the change in available flow in the Chattahoochee River, including dissolved oxygen (DO), temperature, and biota.

For water quality impacts, the most critical period for evaluation is under critical low flows (drought conditions) and high temperatures. During low flow periods, if the natural streamflow is lower than the proposed IFPT, no pumping from the Chattahoochee River will be allowed. Since the Applicant's Proposed Project will not change the available streamflow below the proposed intake during these critical low flow periods, it will not cause a change in the water quality-based compliance status of the waters below the intakes.

The permit limits for five existing point source discharges (see Chapter 3) were developed based on the A7Q10 flow at the discharge locations. Permitted parameters addressed in the discharge permits including pH, biological oxygen demand, ammonia, DO, and total suspended solids. Because the proposed IFPT to protect low flow conditions meets and/or exceeds the A7Q10 flows at either White Creek or Glades Reservoir river intake locations, the water quality standards in the Chattahoochee River below the intake are expected to be met and will not be affected by the proposed pumping. A modeling analysis using Georgia's DOSAG Model indicated that the DO standards will be met at the critical low flow IFPTs evaluated. The simulated DO level below the proposed intake is well above the required 6.0 milligrams per liter (mg/L), as the proposed IFPT targets would be maintained in the Chattahoochee River below the proposed intake.

It is important to note that point sources are not the primary cause of listings for the impaired streams in the upper Chattahoochee River Basin. Non-point source pollution (caused by rain events/stormwater pollution) or urban runoff has been identified as the potential sources for the fecal coliform or occasional biota violations. Instream fecal coliform levels will not be affected by the change in river flow resulting from the proposed filling or operation of the reservoir during critical low flow conditions under any IFPT scenario (A7Q10, M7Q10, and 2-stage), as these are dry weather periods and the source of the impairment has been identified as stormwater pollution.

The Upper Chattahoochee River currently meets the specified water quality criteria for pH, DO, and temperature. The compliance status for these parameters is expected to remain "supporting" after the operation of the project under any IFPT scenario (A7Q10, M7Q10, and 2-stage).

The biota impaired stream segments in the upper Chattahoochee River Basin are upstream of the proposed intake and would not be impacted by the operation of the Proposed Project.

4.4.2 Water Quality in the Proposed Reservoirs

An analysis was completed to predict the water quality in the Glades and White Creek reservoirs once constructed. Modeling of the proposed reservoirs was completed using a spreadsheet-based model – the Lake Loading Response Model (LLRM). The watershed model within LLRM predicts annual loading of nutrients from the watershed to the reservoir based on land cover and hydrology. The lake response model uses predicted watershed loads and empirical relationships from the literature to predict the annual average of typical eutrophication-related parameters, such as total phosphorus (TP), chlorophyll *a*, and Secchi transparency. These predictions are used to assess the likely surface water quality of the reservoirs. LLRM is then used to assess alternate scenarios such as reduced or increased pumping rates from the Chattahoochee River, changes in future land use in the watershed, or implementation of watershed best management practices (BMP) for control of phosphorus. Assumptions for the model are discussed in the LLRM Model of Proposed Glades and White Creek Reservoirs Technical Memorandum, included in the **Appendix R**.

4.4.2.1 LLRM Model of the Proposed Glades and White Creek Reservoirs

The current TP loading to the proposed Glades and White Creek reservoirs was assessed using the LLRM methodology (AECOM 2009), which is a land use export/lake response model developed for use in lake and reservoir management.

The direct and indirect non-point sources of water and TP to the proposed Glades and White Creek reservoirs include:

- Atmospheric deposition (direct precipitation to the reservoirs)
- Surface water base flow (dry weather tributary flows, including any groundwater seepage into streams from groundwater)
- Stormwater runoff (runoff draining to tributaries or directly to the reservoir)
- Waterfowl (direct input from resident and migrating birds)
- Direct groundwater seepage
- Water pumped from the Chattahoochee River

Calculating TP loads to the proposed reservoir requires estimation of the sources of water to the proposed Glades and White Creek reservoirs. The three primary sources of water are: (1) atmospheric direct precipitation, (2) runoff, which includes all overland flow to the tributaries and direct drainage to each reservoir, and (3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to each reservoir (i.e., groundwater). Baseflow is roughly equivalent to dry weather flows in streams and direct groundwater discharge to the ponds. For scenarios that include pumping of water from the Chattahoochee River, those water volumes are added to Glades or White Creek reservoirs as water discharged directly to the reservoir. The baseline annual water budget, estimated based on current land use and hydrology, is broken down into its components in **Table 4.32**.

Table 4.32 Estimated Baseline Annual Water Budgets (Hydraulic Inputs and Water Loading)

Water Budget	Glades Reservoir gallons/yr	White Creek Reservoir gallons/yr
Atmospheric Deposition	17,700	9,700
Watershed Runoff	52,800	34,800
Watershed Baseflow	74,500	45,100
Total	145,000	89,600

Note: Budgets are based on current land use and without pumping from the Chattahoochee River.

Phosphorus Loading Assessment

The overall watersheds of the proposed Glades and White Creek reservoirs consist of a mixture of rural, agricultural, residential, and urban land uses. These developed land use categories typically mean abundant nutrient sources due to soil disturbance, application of fertilizers, and the presence of impervious cover (which allows phosphorus in runoff to remain mobile in the developed areas of the watershed) tend to yield a large portion of the nutrient load to the reservoirs. By contrast, natural land covers, such as forest and wetland, contribute lower nutrient sources due to lower runoff and increased infiltration and uptake. TP loads were estimated based on literature values of runoff and groundwater land use export coefficients. The estimated watershed load to each reservoir, coupled with direct sources of phosphorus, was input into a series of models that provided predictions of in-reservoir TP concentrations, chlorophyll *a* concentrations algal bloom frequency and water clarity.

TP was predicted based on the empirical relationship developed by Reckhow (1988) for southeastern U.S. lakes and reservoirs. All other predictions were based on the predicted TP concentration and equations referenced in **Appendix R**. In a typical application of the model, the estimated load and reservoir concentration predictions would be compared to measured reservoir concentrations. However, since the reservoirs do not currently exist, this step could not be taken. The model predictions could be verified once the reservoir is built and monitoring data describing loading and reservoir concentrations become available. Predicted in-reservoir TP concentrations for Glades and White Creek reservoirs were within the range of concentrations reported by Reckhow (1988) in the dataset of 70 southeastern U.S. lakes and reservoirs.

Phosphorus is typically the nutrient in shortest supply in inland lakes and reservoirs (Schindler 1977, Wetzel 2001, Cooke, et al 2005) and therefore phosphorus availability is likely to be the primary limiting factor for biologic productivity in the Glades and White Creek reservoirs. Phosphorus concentrations will be directly related to all measures of trophic state such as; chorophyll a, Secchi transparency and the frequency of algal blooms.

The estimated existing TP loads to the proposed Glades and White Creek reservoirs, by source, are presented in **Table 4.33**. also includes estimated loads in 2060 using projected 2050 land use data. Loading from the watershed was overwhelmingly the largest source of phosphorus to each proposed reservoir without the inclusion of water from the Chattahoochee River. If water from the Chattahoochee River is added to the proposed reservoirs, the pumped water becomes a significant source of phosphorus.

Table 4.33 Sources of TP Load to Proposed Glades and White Creek Reservoirs – Without Pumping from Chattahoochee River

	Predicted TP Loads (KG/year) to Glades and White Creek Reservoirs			
	Glades		White Creek	
Sources	Current Conditions	2060 Conditions	Current Conditions	2060 Conditions
Atmospheric	86	86	48	48
Internal	0	0	0	0
Waterfowl	28	28	28	28
Watershed	1542	2114	1195	1612
Total Reservoir Load	1656	2228	1271	1688

Note: without pumping from the Chattahoochee River

While the analysis presented previously provides a reasonable accounting of sources of TP loading to the proposed Glades and White Creek reservoirs, there are several limitations to the analysis:

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.

- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. Land uses were aggregated into classes, which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.
- TP export coefficients, as well as runoff/baseflow exports, were representative, but also had limitations as they were not calculated for the study water body, but rather are regional estimates.
- Water quality data for the proposed Glades and White Creek reservoirs do not exist, restricting calibration of the model.

Trophic State Metrics and Assessment

Generally, the trophic state of a reservoir refers to the biological production, both plant and animal life, that occurs in a reservoir. The level of production that occurs is determined by several factors, but primarily by the phosphorus supply to the reservoir and by the volume and residence time of the water in the reservoir.

Table 4.34 and **Table 4.35** summarize a number of metrics related to trophic state, including mean annual Secchi transparency, mean annual chlorophyll *a*, peak chlorophyll *a*, and the probability of an algal bloom with a chlorophyll *a* concentration greater than 15 micrograms per liter (µg/L) in the summer. These metrics suggest that under current watershed conditions after filling, Glades Reservoir would exhibit low (oligotrophic) to moderate (mesotrophic) productivity (**Table 4.34**). Conditions in 2060 would be similar; however, biologic productivity would be somewhat higher, closer to mesotrophic. Under all scenarios where Chattahoochee River water is added to Glades Reservoir, trophic state metrics suggest that the reservoir would be more productive than without the addition of Chattahoochee River water. Water quality under scenarios which involve the largest transfers of water is predicted to be moderately productive (mesotrophic) exhibiting 20-20% higher algal growth and a nearly 10% reduction in water clarity relative to scenarios that do not involve river water transfers to Glades Reservoir. Nearly all of the increase in biologic productivity is attributable to the relatively high phosphorus concentrations currently observed in the Chattahoochee River (a mean of 50.7 µg/L from 2002 through 2012 at USGS station 1201030401 at Belton Bridge). Biologic productivity is predicted to be proportional to the amount of water pumped from the river to the proposed reservoir.

The proposed White Creek Reservoir under current conditions would be substantially more productive than the proposed Glades Reservoir (**Table 4.34**). Trophic metrics suggest that the proposed White Creek Reservoir would be mesotrophic to eutrophic without pumping from the Chattahoochee River. The proposed reservoir would also be mesotrophic to eutrophic under all scenarios evaluated that included the addition of water pumped from the

Reservoir Trophic Categories

oligotrophic – low productivity supporting only a sparse growth of algae and other organisms

mesotrophic – moderate productivity; in between oligotrophic and eutrophic

eutrophic – high productivity; abundant accumulation of nutrients that support a dense growth of algae and other organisms

Chattahoochee River; however, the in-reservoir phosphorus concentrations would not be much different than concentrations without the addition of river water because the concentrations in the river water are relatively close to the concentrations predicted for the reservoir without river inputs. The watershed of the proposed White Creek Reservoir has a larger proportion of agricultural land compared to the watershed for the proposed Glades Reservoir, which results in much higher predicted phosphorus export from the watershed to the proposed reservoir. This increased phosphorus load is predicted to fuel substantial algal growth in the proposed White Creek Reservoir with some summer algal blooms.

Table 4.34 Water Quality Parameters – Current Conditions

Alternative #	Alternative ID	Current Water Volume (million m3/yr)		TP Load	Mean Annual TP	Mean Secchi Disk Transparency	Mean Chlorophyll *a*	Peak Chlorophyll *a*	Probability of Summer Bloom (Chl *a* > 15 µg)
		River	Total	(kg/yr)	(µg/L)		(µg /L)	(µg /L)	
Applicant's	L18-G50-PT	47.3	85.6	3592	15	2.9	5.0	17.7	0.7%
1	L18-G42-PT	36.1	74.4	3024	14	3.0	4.8	17.0	0.6%
2	L18-G42-PL	40.1	78.4	3227	14	3.0	4.9	17.3	0.6%
3	L18-G42-WTP	40.1	78.4	3227	14	3.0	4.9	17.3	0.6%
4	L30-G30-PT	19.8	58.1	2197	13	3.1	4.4	15.8	0.4%
5	L30-G30-PL	23.8	62.1	2400	14	3.1	4.5	16.2	0.4%
6	L30-G30-WTP	23.8	62.1	2400	14	3.1	4.5	16.2	0.4%
7	L43-G17-PT	2.5	40.7	1320	12	3.4	3.9	14.1	0.2%
8	L43-G17-PL	6.4	44.7	1516	13	3.3	4.1	14.6	0.2%
9	L43-G17-WTP	6.4	44.7	1516	13	3.3	4.1	14.6	0.2%
10	L43-W17-PT	13.6	37.2	1957	21	2.2	8.1	27.9	7.0%
11	L43-W17-PL	16.0	39.7	2084	22	2.2	8.2	28.1	7.3%

[1] Total P loading estimated based on mean TP concentration of 50.7 µg/L in the river water.

Table 4.35 Water Quality Parameter – 2060 Conditions

Alternative #	Alternative ID	Current Water Volume (million m3/yr) River	Current Water Volume (million m3/yr) Total	TP Load (kg/yr)	Mean Annual TP (µg/L)	Mean Secchi Disk Transparency	Mean Chlorophyll *a* (µg/L)	Peak Chlorophyll *a* (µg/L)	Probability of Summer Bloom (Chl *a* > 15 µg)
Applicant's	L18-G50-PT	47.3	85.3	3992	16	2.8	5.6	19.6	1.3%
1	L18-G42-PT	36.1	74.1	3424	16	2.8	5.4	19.2	1.1%
2	L18-G42-PL	40.1	78.1	3628	16	2.8	5.5	19.3	1.2%
3	L18-G42-WTP	40.1	78.1	3628	16	2.8	5.5	19.3	1.2%
4	L30-G30-PT	19.8	57.8	2597	15	2.9	5.2	18.4	0.9%
5	L30-G30-PL	23.8	61.8	2800	15	2.8	5.3	18.6	1.0%
6	L30-G30-WTP	23.8	61.8	2800	15	2.8	5.3	18.6	1.0%
7	L43-G17-PT	2.5	40.5	1720	15	3.0	4.9	17.5	0.7%
8	L43-G17-PL	6.4	44.4	1917	15	2.9	5.0	17.7	0.7%
9	L43-G17-WTP	6.4	44.4	1917	15	2.9	5.0	17.7	0.7%
10	L43-W17-PT	13.6	37.0	2375	24	2.0	9.6	32.8	12.9%
11	L43-W17-PL	16.0	39.5	2501	24	2.0	9.7	32.8	12.9%

[1]Total P loading estimated based on mean TP concentration of 50.7 µg/L in the river water.

4.4.2.2 Potential for Thermal Stratification

Both the Glades and White Creek Reservoirs are expected to thermally stratify during the warm weather months. This will result in a shallow warm mixed layer at the surface (epilimnion), a transition zone (thermocline or metalimnion) and a cold unmixed layer deeper in the reservoirs (hypolimnion). The volume of the hypolimnion in Glades and White Creek Reservoirs can be approximated by the volume of water that exists below the photic zone. The photic zone depth can be estimated as three times the predicted Secchi transparency (Lee et al. 1995) or 10 meters (33 feet) in Glades and 7 meters (23 feet) in White Creek Reservoir. Water below this depth is expected to be isolated from surface mixing and aeration during the summer and substantially colder than surface water. This colder water can be made available for selective withdrawal from the reservoirs to cool tailwaters below the dams. Alternatives which increase the potential for increased trophic state (i.e., make the reservoirs more nutrient rich) would also increase the potential for oxygen depletion in the hypolimnion. Strong stratification and commensurate oxygen depletion at depth would be expected to occur during the warmest months of the year or roughly June through October. Severe oxygen depletion may lead to and increase the potential for dissolution of iron and manganese and formation of hydrogen sulfide in the hypolimnion.

In Glades Reservoir the potential volume of hypolimnetic water is estimated to be 2,423 MG out of a total reservoir usable volume of 9,367 MG or approximately 26% of the volume of the reservoir. In White Creek Reservoir, the potential volume of hypolimnetic water is estimated to be 958 MG out of a total reservoir usable volume of 3,396 MG or approximately 28% of the volume of the reservoir. Because White Creek Reservoir is projected to be more nutrient rich than Glades, it is anticipated that the potential for hypoxia in the hypolimnion is higher. Alternatives for pumping larger volumes of Chattahoochee water to either reservoir increase the nutrient concentrations of the reservoirs and would increase the probability that hypoxia would occur in the reservoirs.

4.4.2.3 Sedimentation in Proposed Reservoirs

The sediment volume in the proposed reservoirs were calculated based on the watershed (drainage) area for Glades and White Creek Reservoirs, future land use conditions, and sediment volume curves developed for existing small reservoirs in North Georgia based on Natural Resources Conservation Services (NRCS) recommended methodology and data collected by NRCS for these existing reservoirs. **Table 4.36** summarizes the estimated range and average of sediment volume that would accumulate over a 50-year period. The safe yield analysis is based on usable water supply volume that is approximately 80% of total reservoir storage volume. It is assumed that 20% of the total storage volume would be reserved for storing sediments from the watershed and from water pumped from the Chattahoochee River. This assumption is more conservative than the estimated sediment volume using the NRCS methodology, which is acceptable for planning as sediment data is specific to each watershed.

Table 4.36 Estimated Sediment Volume in the Proposed Reservoir

Reservoir Site	Watershed Drainage Area (sq. mi)	Estimated Range of Sediment Pool Volume (ac-ft)	Estimated Average Sediment Pool Volume (ac-ft)
Glades	17.6	310 to 600	395
White Creek	10.2	180 to 350	301

4.4.3 Downstream Water Quality Effects

Based on the hydrological modeling, the addition of system storage (either with Glades Reservoir or White Creek Reservoir) could result in slightly beneficial effects to Lake Lanier and has negligible to minimum effects on the operation of the ACF system downstream of Lake Lanier as compared to the No Action Alternative. A portion of the nutrients and sediments currently in the Chattahoochee River would be transferred to the proposed Glades and White Creek reservoirs with the proposed water transfers. A portion of these sediments and nutrients would be settled in the reservoirs and an additional portion would be removed in water supply withdrawals. In addition, a portion of the nutrients originating upstream of the proposed Glades and White Creek Reservoirs (currently entering the Chattahoochee via Flat and White creeks) would also be settled in the reservoirs or removed in water supply withdrawals. The net effect would be somewhat lower loads of nutrients and sediment to Lake Lanier than is occurring currently. Therefore, no adverse water quality effects are anticipated from the construction of the Applicant's Proposed Project and alternatives. The potential impacts on water quality in Lake Lanier and in downstream reservoirs, similar to the hydrological modeling of the ACF River Basin, would be a result of overall system demand increase (cumulative effects instead of direct and indirect effects).

4.4.4 Watershed Protection and Management

Georgia Rules for Environmental Planning Criteria establish guidelines for protection of Water Supply Watersheds in Georgia Code 391-3-16-.01: Criteria for Water Supply Watersheds. Within this code, distinct minimum protection criteria are established for watersheds around governmentally owned public drinking water supply intakes and reservoirs, this excludes the multipurpose reservoirs owned by the Corps. The criteria are different for large water supply watersheds, defined as watersheds of 100 square miles (sq mi) or more, and small water supply watersheds, less than 100 sq mi.

The minimum criteria for large water supply watersheds, as they apply to our project area, are indicated below:

- Stream corridors of a tributary to the water supply intake shall have no specified minimum criteria for protection

The minimum criteria for small water supply watersheds are indicated below:

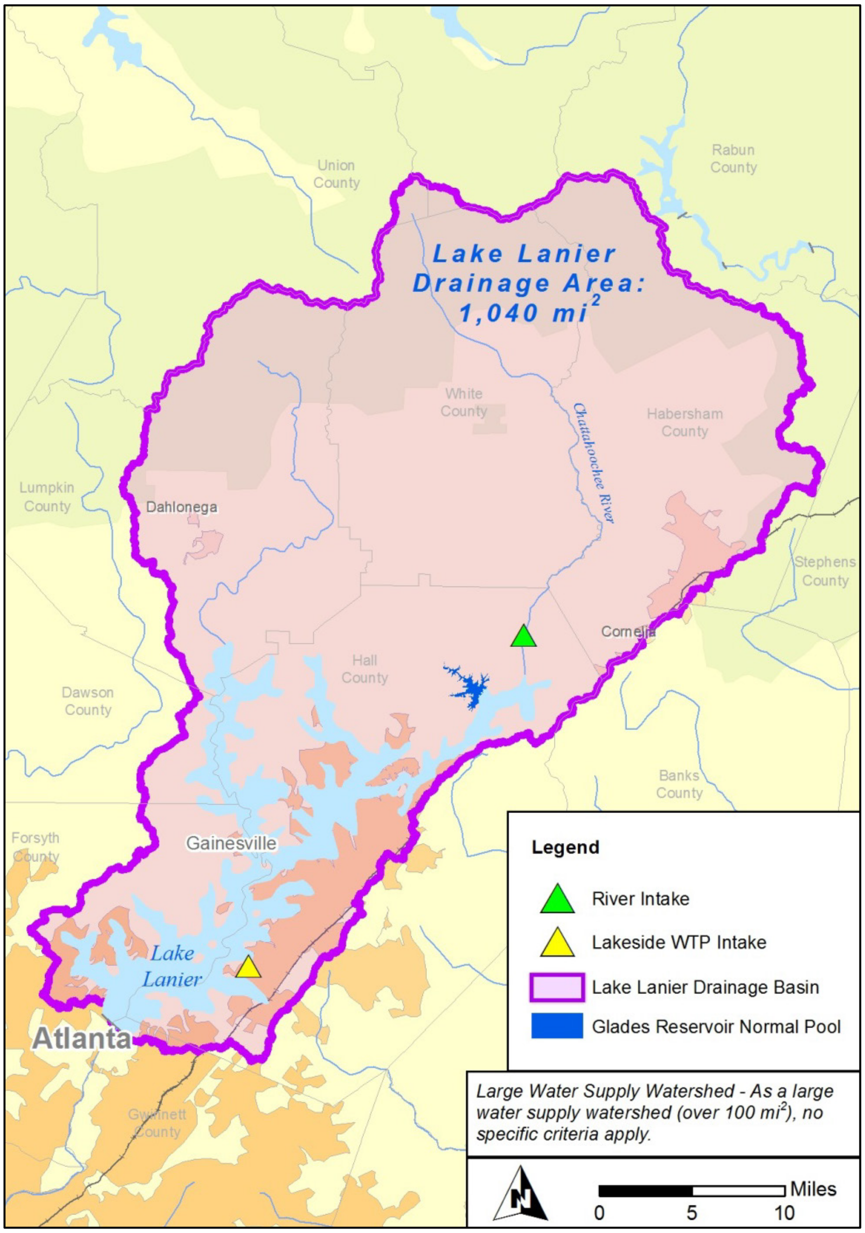
- Perennial stream corridors within a seven mile radius upstream of the water supply intake and water supply reservoir are protected by the following criteria:
    - A buffer shall be maintained for a distance of 100 feet on both sides of the stream as measured from the stream banks.
    - No impervious surface shall be constructed within a 150 foot setback on both sides of the stream as measured from the stream banks.
    - Septic tanks and septic tank drainfields are prohibited in the impervious setback area

Table 4.37 identifies which set of the above watershed protection criteria apply to each alternative. Additionally, depictions of the protected areas are shown in **Figure 4.57** through **Figure 4.60**.

Table 4.37 Water Supply Watershed Protection Criteria

		Glades Reservoir		White Creek Reservoir	
Alternative #	Alternative ID	Large Water Supply Watershed	Small Water Supply Watershed	Large Water Supply Watershed	Small Water Supply Watershed
Applicant's	L18-G50-PT	X			
1	L18-G42-PT	X			
2	L18-G42-PL		X		
3	L18-G42-WTP	X			
4	L30-G30-PT	X			
5	L30-G30-PL		X		
6	L30-G30-WTP	X			
7	L43-G17-PT	X			
8	L43-G17-PL		X		
9	L43-G17-WTP	X			
10	L43-W17-PT			X	
11	L43-W17-PL				X

Figure 4.57 Large Water Supply Watershed – Glades Reservoir



Draft Environmental Impact Statement

Figure 4.58 Small Water Supply Watershed – Glades Reservoir

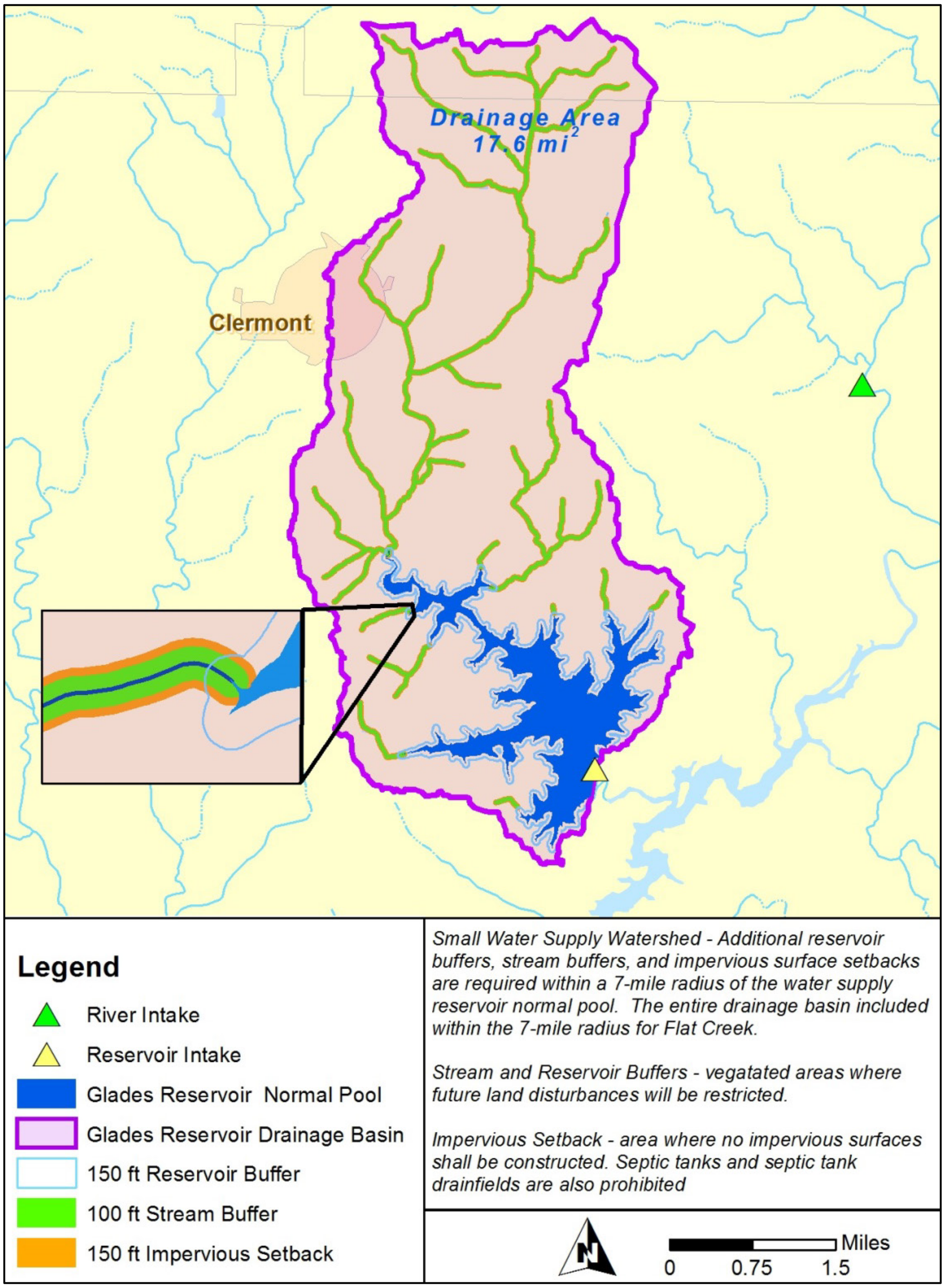


Figure 4.59 Large Water Supply Watershed – White Creek Reservoir

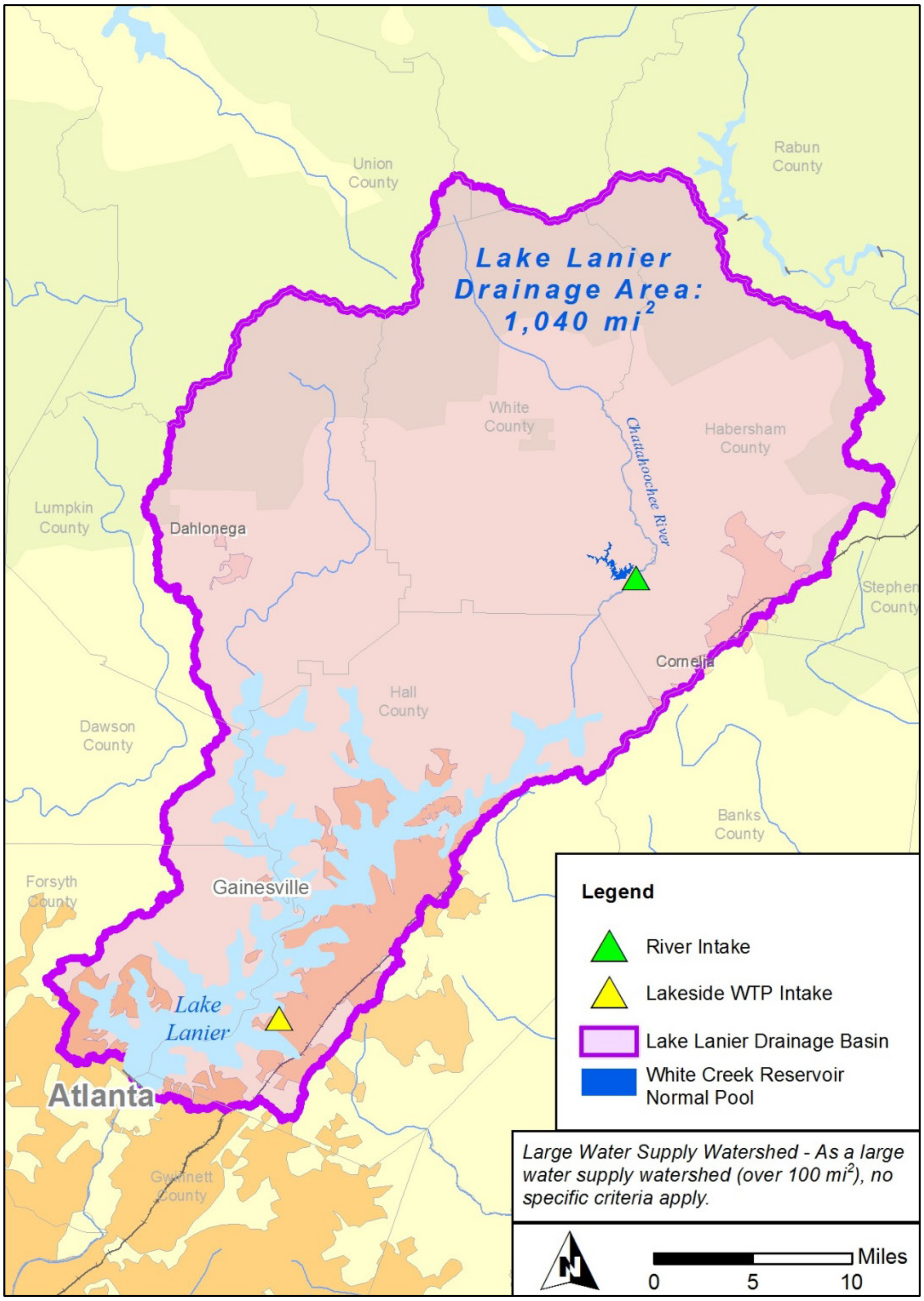


Figure 4.60 Small Water Supply Watershed – White Creek Reservoir